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CITY OF MANCHESTER.

Rivers Department.

ANNUAL REPORT

FOR THE

Year ending March 31st, 1932.

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RIVERS DEPARTMENT

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Annual Report

FOR THE

YEAR ENDING MARCH 31st, 1932.

Rivers Department,
Ship Canal House,
King Street,
Manchester.

MEMBERS OF THE RIVERS COMMITTEE,

1931-1932.

CHAIRMAN—Councillor G. Harold White, J.P.

DEPUTY-CHAIRMAN—Councillor S. P. Dawson, M.M.

THE LORD MAYOR
(The Right Honourable Ellis Green).

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CONSULTING CHEMIST—Edward Ardern, D.SC., F.I.C.

SECRETARY—William Porthouse.

SEWAGE WORKS MANAGER—Charles H. Fall.

RESIDENT CHEMIST—Clarence Jepson, M.SC., A.I.C.

RESEARCH CHEMIST—William T. Lockett, M.SC.

(617)

CITY OF MANCHESTER.

RIVERS DEPARTMENT.

ANNUAL REPORT FOR THE YEAR ENDING MARCH 31ST, 1932.

The Rivers Committee submit to the Council the following report on the work of the Rivers Department :—

Introductory.

The duties of the Rivers Committee are defined in the Council's Instructions to Committees, as follows :—

> " To enforce and carry out the provisions of any public or local Act, or any legal remedy with respect to the rivers, brooks, or streams, wholly or partially within the City, and with respect to all other matters connected therewith ;
>
> " That the said Committee be authorised and instructed to carry out and complete the Manchester Main Drainage Scheme, including all works in relation thereto, and for those purposes to exercise the powers of the Corporation under the Public Health Acts ;
>
> " Also to execute the powers and duties of the Council with respect to the Sewage Outfall and Main Drainage Works of the Corporation under paragraph 2 (2) of the Fifth Schedule of the Manchester Corporation (General Powers) Act, 1904 (Chorlton-cum-Hardy Sewage Works to be used only for the three Withington Wards and the Urban District of Levenshulme as then defined) ; Part IV. (Sewerage) of the Manchester Corporation Act, 1908 : Part V. (Sewerage) of the Manchester Corporation Act, 1909 ; Part IV. (Main Drainage Works) (except section 50) of the Manchester Corporation Act, 1911 ; Part VI. (Sewerage) of the Manchester Corporation Act, 1920 ; Part VIII. (Main Drainage) of the Manchester Corporation Act, 1924 ; and under any other local enactment ; also the provisions as to the discharge of certain matters into sewers, contained in section 21 of the Manchester Corporation (General Powers) Act, 1902, and the orders thereunder ; also to carry out and enforce the provision enabling the Corporation to define the boundaries of rivers, brooks, and watercourses contained in section 55 of the Manchester Corporation Act, 1911 ;
>
> " Also to carry out the powers and duties of the Council under the following portions of the Manchester Corporation Act, 1914, viz. :—Part VI. (Main Drainage Works) and the following sections of Part VIII. (Miscellaneous), viz. :—Sections 48 (Maintenance and repair of banks of River Mersey), 50 (Watercourses not to be

covered in except in accordance with approved plan), 51 (Chemical refuse, steam, etc., not to be turned into culverted watercourse), 52 (Owners to repair and cleanse culverts), 53 (Corporation may define levels of rivers, brooks, and watercourses), 54 (Removal of weirs), 55 (Exemption of Canals), 71 (For protection of the Stretford Gas Company), 72 (2) (For the protection of the Cheshire Lines Committee), 73 (For further protection of the Trafford Power Company), Sub-sections (16), (18), and (19) of section 74 (For protection of Manchester Ship Canal Company), and Section 76 (For protection of Lord Egerton's Trustees) ;

" Also to direct and manage the powers, authorities, and duties of the Council under the Rivers Pollution Prevention Acts, 1876 and 1893, section 14 of the Local Government Act, 1888, and sections 16, 17, and 47 of the Public Health Acts Amendment Act, 1890 ;

" Also to carry out and enforce the following provisions contained in the Public Health Act, 1925 :—

Section 40 (Power to require specially enlarged sewer in new street). (In common with the Paving, Sewering, and Highways Committee and the Improvement and Buildings Committee.)

Section 41 (Prevention of entry of petrol, etc., into sewer). (In common with the Public Health Committee and the Paving, Sewering, and Highways Committee.)

Section 51 (Power to require the covering in of watercourses and ditches). (In common with the Paving, Sewering, and Highways Committee and the Improvement and Buildings Committee.)

Sections 54 (Watercourse choked up to be a nuisance under the Public Health Act, 1875), and 55 (Power of local authority to defray cost of or execute works). (In common with the Paving, Sewering, and Highways Committee and the Public Health Committee) ;

" And that the said Committee shall have, and this Council hereby delegate to the said Committee, all and every the powers, authorities, and discretion which, by the said Acts, in relation to the matters and purposes aforesaid, are now given to, or vested in, this Council ;

" And the said Committee are hereby authorised to carry out the instructions heretofore given to the Rivers Committee, or which may, from time to time, be given to the said Committee by this Council."

Recent Main Drainage.

The total length of sewers constructed and completed to date is 30·39 miles, viz.:—Manchester Main Drainage Scheme 24·09 miles, under the Manchester Corporation Act, 1908, 0·93 miles, to the relief of flooding in Moss Side and Whalley Range 2·14 miles, and at Wythenshawe 3·23 miles. Of this total, 6·59 miles were executed by the Committee's staff without the intervention of a contractor.

The sewers vary in size from 2·25 ft. to 15·25 ft. in diameter. They are constructed with red engineering bricks and shale bricks set in cement mortar. No surface clay bricks have been used.

Owing to the presence of water in the subsoil, considerable lengths of sewer have had to be executed under air pressure. The completed sewers pass beneath the London, Midland, and Scottish, the London and North Eastern, the Manchester, South Junction, and Altrincham, and the Cheshire Lines Committee Railways in seventeen places, and cross the Bridgewater Canal in seven places.

Sewage Disposal.

The Rivers Committee control the admission of all trade effluents into the sewers, according to the provisions of the before-mentioned Acts, and a special Inspector has charge of this work.

The main activity of the Committee is, however, connected with the disposal of the City sewage.

The bulk of the City sewage is dealt with at the main outfall works, Davyhulme, but the sewage from the Withington district is treated separately at the Withington Works, Chorlton-cum-Hardy, whilst some proportion of the Northenden sewage is dealt with at the purification works, taken over from the Bucklow Rural District Council, situate on the banks of the Mersey below Northenden Bridge.

In addition, the sewage from the Borough of Middleton and from the parish of Davyhulme, together with some portions of the sewage from the Audenshaw, Droylsden, Great and Little Heaton, Royton, and Stretford areas, also passes to the Davyhulme works. A portion of the old Moss Side works at Urmston is still retained for the treatment of storm-water only, and the Middleton sewage works have been reconstructed to provide for the treatment of a certain proportion of the storm-water from this district.

Period covered by the Report.

Attention is directed to the fact that from now onwards the period covered by the Annual Report of the Department will be the 12 months ending March 31st, and not, as previously was the case, a 52-week period, with every leap year a 53-week period. This alteration brings the report into alignment with the financial returns of the City Treasurer. In order to effect this change, the period covered by the present report is the 372 days ending 31st March, 1932.

Expenditure.

The following statements show in summarised form the details of the Committee's expenditure for the year under review :—

The total charge on the rates in respect of the work of the Committee was £222,054 4s. 10d.

Of this amount, a sum of £49,843 15s. 10d. was required for the upkeep of the Davyhulme, Withington, Moss Side, Middleton, and Gorton Sewage Works, and for general rivers work, comprising the administration at the Central Office, Ship Canal House, the cost of labour and various rivers improvements, contribution to the Mersey and Irwell Joint Committee, etc.

The remainder, amounting to £172,210 9s. 0d., was applied in the payment of interest on loans and repayment of debt on the capital outlay on intercepting sewers throughout the whole of the City, and on the purification plant at the various sewage works.

The details are as follow :—

	£	s.	d.	£	s.	d.
Administration and Upkeep.						
Davyhulme Sewage Works..	*35,621	15	6			
Withington	6,904	6	2			
Moss Side	129	8	11			
Gorton	335	17	6			
Middleton	253	0	4			
Northenden	722	4	7			
Rivers and Streams	5,579	3	6			
Main Drainage Scheme	297	19	4			
				49,843	15	10
Interest on Loans and Repayment of Debt.						
Manchester	†63,180	14	10			
Withington	4,723	5	4			
Moss Side	0	0	0			
Gorton (Credit)	‡161	19	9			
Middleton	168	19	1			
Northenden	1,029	14	0			
Rivers and Streams	0	0	0			
Main Drainage Scheme	97,054	17	5			
Wythenshawe..	6,214	18	1			
				172,210	9	0
Total				£222,054	4	10

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* This amount represents the net cost to Manchester after deducting contributions from Audenshaw, Stretford, Barton, and Middleton Authorities (see Table IV. footnote).

† Included in this figure is a sum of £31,000 (approximately), the annual charge on the capital outlay on the Manchester Sewers (apart from the Main Drainage Scheme, 1911), amounting to £627,091, and certain payments in respect of the Middleton Sewage Works.

‡ Capital payments, £183 13s. 6d.
Credit for transfer of Land, £345 13s. 3d.

Staff.

During the year Mr. George F. Walter, the Secretary of the Rivers Department, retired on superannuation after 38 years' service, and was succeeded by Mr. William Porthouse, who has been in the Department since 1901.

The Committee entered into an arrangement with Mr. Reginald Marker for services as Nautical Adviser in the design and construction of the new sludge steamer "Mancunium."

Descriptive Notes of the Davyhulme and Withington Sewage Works.

To meet the needs of the numerous visitors to Manchester, the Secretary prepared a booklet of Descriptive Notes of the Davyhulme and Withington Sewage Works, illustrated by photographs. This was published in the summer of 1931, and has proved very useful. Illustrated and up-to-date notes on the work of the Department, written by the Secretary, appear in the annual publication of the Corporation, "How Manchester is Managed."

Records and Costs of Sewage Disposal Operations.

A return of the records and costs of the sewage disposal operations of the Department for the year ended 31st March, 1931, has been supplied during the year to the Minister of Health, in accordance with the Minister's circular-letter 1,165 to Local Authorities, dated 31st January, 1931. A similar return will be supplied annually in the future. Assistance and advice was given to the sewage disposal department of a large Corporation engaged in the formation of a system of cost accountancy for the same purpose.

Land at Cleveland Road, Crumpsall.

The Department purchased in 1889 a small plot of land at the foot of Cleveland Road, Crumpsall, abutting on the River Irk, for the passage of the B2 sewer. In October, 1931, permission was given for the Paving, etc , Committee to construct a storm-water overflow sewer through the land. Notwithstanding repeated efforts to find a permanent tenant, this land has lain vacant until this year, but has now been let for cultivation and poultry farming.

Quinquennial Valuation of the Committee's Properties.

The City Surveyor has made his quinquennial valuation of the properties under the control of the Rivers Committee on the 31st March, 1931, and has reported a total value of £702,706. This is an increase of £99,351 on the figures at the 1926 valuation. The increase is due to the extensions which are now proceeding at the Davyhulme Sewage Works.

Rating and Valuation (Apportionment) Act, 1928: Industrial Hereditaments.

Objection was raised by the Revenue Authorities to certain land belonging to the Department in the River Mersey meadows at Flixton being derated as agricultural land, because of the fact that the Department used that land partly for the disposal of sewage sludge. Counsel was briefed to conduct the Corporation's case before the Local Assessment Committee. The objection of the Revenue Authorities was upheld, and the Corporation are thus not entitled to the benefits of derating in respect of this land.

Similarly, claims for derating the Davyhulme and Withington Sewage Works were rejected on the grounds of "non-industrial" occupation.

Land at Thornbury Road, Stretford.

In the private Act of 1911, the Corporation obtained powers to acquire a plot of land at Thornbury Road, Gorse Hill, Stretford, for the passage of the new main outfall sewer to the Davyhulme Sewage Works, and entered into a covenant with the De Trafford Estates to fence off the land when called upon to do so. During the year under review house-building development of adjoining lands has called for the fulfilment of this long outstanding covenant, and fencing operations are now in progress.

MAINTENANCE OF RIVERS AND STREAMS.

The time of the river men has been distributed as follows :—

River Medlock.	Days
Palmerston Street to Pin Mill Bridge	42
Pin Mill Bridge to Fairfield Street	19
North Western Street to Mayfield Tunnel	14
Boardman Street to Downing Street	18
Downing Street to Tennant's Tunnel	17
Green Lane Basin to Princess Street	32
Princess Street to Charles Street	14
Cornbrook, Ley Brook, Gore Brook, Ball Brook, and River Irk	27
Westhead's Weir.	
Drawing weir at week-ends and impounding water	19
Attending sluices during floods	33
Clearing obstructions, repairs, etc.	38
Birley's Weir	2
Green Lane Depot.	
Repairing waders and tackle, breaking up debris, lime-washing, and general work at Mess House	30
Posting warning notices *re* tipping at various places	3
Assisting Rivers Inspector in examinations of trade refuse entering sewers and general rivers work	241

Infringements of Manchester Corporation Acts, 1869, 1871, 1884, etc.

Cases of infringement of the above Acts usually consist of tipping on river banks within reach of floods, the placing of obstructions in waterways, and the casting of solid refuse into streams. Twenty-six cases have been dealt with. Resort to legal notice has been necessary in a few instances, but in the majority of cases the work required has been carried out by the offenders when their attention has been called to the matter. Occasionally the work has been done by the Corporation men at the owner's cost.

Trade Refuse entering Sewers.

A large number of examinations of trade effluents from works discharging into the Corporation sewers have been made, and representations have been made to manufacturers whose works effluents have been considered to be of an unsatisfactory nature.

The complaints have usually been concerned with excessive solids in suspension, acids, and sulphides.

Floods.

Several heavy floods have occurred in the River Mersey, notably on the 6th January, 1932, when a large amount of damage was done. The water rose to the undermentioned heights above low-water level :—

	ft.	in.
Cheadle Bridge	14	0
Didsbury Mill	15	11
Simon's Bridge	13	10
Northenden Weir (on sill)	8	6
Palatine Road Bridge	18	9
Darley Avenue	16	5
Withington Pump House	19	3
Stretford Overflow Weir	15	10

In the River Irwell the water level rose as follows :—

	ft.	in.
Broughton Bridge	14	6
Sherbourne Street Bridge	12	1
Waterloo Bridge	11	0
Victoria Bridge	9	3
Albert Bridge	7	6
Prince's Bridge	6	2
Regent's Bridge	5	6

Plans Approved.

During the year plans have been submitted to the Rivers Committee for the following, viz. :—

Red Lion Brook	Culverting at Withington.
Brook at Northen Etchells..	Culverting at Moss Nook.

Rivers Mersey and Irwell Catchment Board.

The Chairman and Deputy-Chairman of the Rivers Committee, together with the Chairman and Deputy-Chairman of the Agricultural Committee and the City Engineer, have continued to represent Manchester on the Rivers Mersey and Irwell Catchment Board. The first precept of expenditure of the Board has been received and paid by the Corporation during the year, this expenditure being provided for in the Rivers Committee's estimates. A heavier precept is expected for the current year, and provision has had to be made accordingly.

Amalgamation of Wythenshawe District: Schedule of Watercourses.

The extension of the City has laid on the Department the surveillance of a number of watercourses in the Baguley, Northenden, and Northen Etchells districts. The Committee have had a schedule of these watercourses prepared by the Rivers Inspector, with notes of their nature, direction, and condition. The whole district is a network of ditches and small streams, chief among them being the Baguley Brook, which drains the greater portion of the added area ; the Fairywell Brook, which forms the greater portion of the westerly boundary of the district ; the Mill Brook, which is a tributary of the Fairywell Brook, and into which the sewage works effluent of the Baguley Sanatorium is discharged ; and the Gatley Brook, which forms nearly the whole of the easterly boundary of the added area. There are several unnamed brooks, of which one (a tributary of the Baguley Brook) receives the effluent from the Corporation's Heyhead sewage installation, and from a private sewage installation near Sharston Green. Another unnamed brook is that at Kenworthy Lane, which receives the effluent from the Northenden Sewage Works before discharge into the River Mersey.

THE TREATMENT OF SEWAGE AT THE WITHINGTON WORKS.

Description of Works.

These works came under the control of the Rivers Committee upon the inclusion of the Withington Urban District Council District within the City on November 9th, 1904. They are situate at Chorlton-cum-Hardy, at the extreme western corner of the district, and are bounded by the River Mersey on two sides—south and west—the Chorlton Brook on the north, and an embankment on the east.

These works were originally designed to purify the sewage by treatment on the land. Subsequently a sedimentation tank and double-contact filter plant was installed as follows:—Two detritus tanks (capacity 83,400 gallons), two sedimentation tanks (capacity 781,000 gallons), ten first contact beds (2,900 superficial yards each), ten second contact beds (2,900 superficial yards each), and an area of storm beds of 12,452 superficial yards divided into four plots measuring respectively 2,882, 3,533, 3,751, and 2,286 superficial yards. A conical catch-pit in connection with the high-level sewer was constructed later (*cf.* report for the year ending March, 1911). In 1914 two Emscher (double-decked) tanks were constructed of sufficient capacity to deal with from 600,000 to 700,000 gallons per day, a general description of which appeared in the report for the year ending March, 1915.

A continuous-flow unit for the treatment of the sewage by the activated-sludge process was brought into operation in October, 1917, and occupies one-third of one of the above-mentioned sedimentation tanks. A complete account of this plant, together with plan, was given in the Annual Report for the year ending March, 1918.

An additional larger activated-sludge unit was brought into commission in August, 1923, and occupies one-third of one of the original second contact beds. A complete description of this installation was given in Appendix I. to the report for the year ending March, 1924; a plan of the same appeared in the Annual Report for the year ending March, 1923.

A general plan showing the arrangement of the present works appeared in the Annual Report for the year ending March, 1923.

The land is practically level throughout; consequently it was found necessary, in order to carry out the scheme of double-contact beds, to raise the sewage at the outfall works, and, in order to avoid pumping the whole, to arrange the new outfall main sewers to gravitate the sewage of the upper zone of the district and the whole of the Levenshulme sewage, leaving only that from Didsbury and Chorlton-cum-Hardy to be pumped.

With the River Mersey and Chorlton Brook at ordinary level, the effluent is passed into the latter at a point some 300 yards above its junction with the Mersey; but when the river and brook are in flood it is passed by a syphon under the Chorlton Brook into the Ousel Brook at a point near the Stretford Cemetery, and about half a mile below the Sewage Works. In addition to this, there is a storm-water reservoir nine acres in area for impounding storm water from the Chorlton-cum-Hardy district, as well as a portion of the effluent from the works. When the River Mersey is about its normal level this storm-water reservoir is discharged by gravitation into the river; but should the river be in flood, it is then pumped by means of a suction-gas pumping installation.

In connection with the present main drainage scheme, arrangements have been made whereby the sewage from Levenshulme and Mauldeth Road can be diverted either to the Withington Works or into the main City outfall.

Since 29th November, 1928, approximately 750,000 gallons per day have been diverted to the Davyhulme Works.

The total population (Withington and Levenshulme) at present connected with the works is 65,000*.

The average daily flow of sewage (including storm water) for the period under observation amounted to 3,483,000 gallons, or 53 gallons per head of population per day.

With the exception of the suction gas plant referred to above, the whole of the power used on the works is now derived from the Corporation Electrical Supply.

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* This figure has been adjusted to meet the continued diversion of a portion of the sewage flow to Davyhulme

The plant in the engine room comprises four centrifugal pumps for lifting the low-level sewage, air compressor for delivering the sludge through mains on to the land, and air compressors for the operation of the activated-sludge installations, all driven from electric motors of from 15 to 60 H.P.

In addition, there are small motors attached to screens placed on high and low-level sewers, and for driving chopping machine.

Area of Land.

The total area of land comprising the Withington Sewage Works amounts to 92·5 acres, and is divided up as follows :—

	Acres.
Land occupied by detritus, sedimentation, and activated-sludge tanks	2·25
Land occupied by buildings and sludge tank	
Land occupied by lay-byes and storage	
Land occupied by storm-water reservoir	9
Land occupied by bacteria beds	11·75
Land occupied by storm-water filters	2·5
Total area of land occupied	25·5
The area of land not occupied by bacteria beds, storm-water filters, buildings, tanks, etc., but under cultivation	67·0
Grand total	92·5

Of the land not utilised for sewage treatment an area of 21½ acres has again been let for a portion of the year as grazing land, an income of £69 17s. 6d. having been received.

River Mersey Banks.

As a result of the heavy flood in the River Mersey on the 6th January, 1932, considerable expenditure has had to be incurred in reconditioning the river banks where the flood water broke through. But for this particular flood, expenditure on bank maintenance during the year would have been trifling.

Volume of Sewage Treated.

The volume of sewage actually delivered at these works is estimated at 1,295,811,000 gallons, an average of 3,483,000 gallons per day. The details of the flow, together with the volume in terms of per head of population and rainfall records, are given in the following table :—

Sewage Flows.

Month	Total flow.	Average daily flow.	Average daily flow.	Rainfall.
	Gallons.	Gallons.	Gallons per head.	Inches.
1931 March 26th to 31st	16,251,000	2,709,000		trace
April	106,793,000	3,560,000		3·22
May	99,446,000	3,208,000		2·83
June	122,336,000	4,078,000		5·16
July	101,471,000	3,273,000		3·29
August	145,200,000	4,684,000		6·99
September	118,060,000	3,935,000		3·07
October	87,402,000	2,819,000		1·47
November	138,191,000	4,606,000		5·44
December	100,170,000	3,231,000		1·35
1932 January	123,095,000	3,971,000		3·21
February	64,189,000	2,213,000		·17
March	73,207,000	2,361,000		1·96
Total for 372 days...	1,295,811,000	3,483,000	53	38·16
Total for 52 weeks ending Mar. 25th, 1931	1,331,703,000	3,659,000	57	37·49

A measurable rainfall occurred on 191 days, as compared with 212 days during the previous year.

Sludge Disposal.

In the following table is given the amount of sludge removed during the year from the various tanks :—

	Tons
Screening, etc.	340
Conical Tank	590
Detritus Tanks, Sedimentation Tanks, and Activated-sludge Tanks	17,190
Emscher Tanks	440
Total	18,560

The total amount of sludge produced, viz., 18,560 tons, is equal to 14·3 tons per million gallons.

The sludge from the detritus, sedimentation tanks, and activated-sludge tanks has been trenched into the land as usual.

Emscher Tanks.

A general description, together with plan, of these tanks was given in the Report for the year ending March, 1915.

The tanks have been in continuous operation throughout the year and have dealt with 282,442,000 gallons of sewage, an average of 759,000 gallons per day, as compared with a daily flow of 693,000 gallons during the preceding year.

A total of 230 tons of sludge was discharged from the tanks on to the drainage beds. The air-dried sludge has been used on the land under cultivation.

In order to avoid the cost of the partial renewal of the drainage beds and with the view of reducing the cost of sludge disposal, means have been provided whereby wet digested sludge may be sent direct on to the farm land. During the period under review 210 tons of digested sludge have been disposed of in this manner and deposited.

A portion of the gas resulting from the digestion of the sludge is collected and used in the laboratory for heating purposes.

Filtration of Effluent from Sedimentation and Emscher Tanks.

Of the total flow of 1,295,811,000 gallons of sewage received at the works 542,110,000 gallons were treated by the activated-sludge process, and the remainder, viz., 753,701,000 gallons, was dealt with on the filtration areas.

The storm beds dealt with a total volume of 94,430,000 gallons, which is equal to 102,000 gallons per acre per day. The primary and secondary beds dealt with a total volume of 659,271,000 gallons, which means that on the average (including all periods of rest), tank effluent was applied to the primary beds at the rate of 295,000 gallons per acre per day.

The work on the surface of the filter beds in connection with the removal of accumulated sludge and of heavy growths of weeds, etc., has proceeded as usual, the cost of which for the various filtration areas is given in Table II.

Treatment of Sewage by the Activated-Sludge Process.

Purification plant in operation for the treatment of sewage by the activated-sludge process—diffused aeration system—consists of (i.) a small continuous-flow unit installed in 1917, and described with plan in the Annual Report for the year ending March, 1918, and (ii.) a large-scale continuous-flow unit installed in 1923 and modified in 1926. A description of the large-scale unit as originally installed is given with plan in the Annual Report of 1923 ; the modifications of 1926 are referred to in the Annual Report of 1927.

The air-compressing plant comprises two reciprocating compressors, driven by 27 and 30 H.P. electric motors respectively, each capable of compressing approximately 700 cubic feet of free air per minute, and a special type compressor (installed in 1924), driven by a 25 H.P. electric motor, capable of compressing 400 cubic feet of free air per minute. One of the larger compressors is used as a stand-by.

The normal working pressure is 4lbs. per square inch.

Each purification unit is provided with meters, etc., for recording the volume of sewage treated and the volume of air used. A meter is also provided for the measurement of the electrical units consumed.

Prior to passing to the aeration tanks the sewage is screened and freed from the coarser suspended solids by passage through detritus tanks having a capacity equivalent to 40 mins. D.W.F. ; and, in the case of the larger unit, the sewage since May 22nd, 1930, has received additional sedimentation.

During the past year the small-scale unit has been in operation for 349 days and the large-scale unit for 372 days, the full period reported upon. The total volume of 542,110,000 gallons of sewage dealt with by these units during the year represents approximately 42 per cent. of the total volume of sewage received at the works.

Details of the performance of these plants are given in the following statements :—

Activated-Sludge Process—Withington Works.

	Small unit	Large unit
Days in operation	349	372
Total volume of sewage treated	121,350,000 gallons	—
Total volume of sedimentation tank liquor treated	—	420,760,000 gallons
Volume of sewage or tank liquor treated per day (average)	348,000 ,,	1,131,000 ,,
Air consumption :—Free air per gallon of sewage or tank liquor treated	1·14 cub. ft.	0·87 cub. ft.
Average detention period (aeration tank)..	4·3 hours	5·5 hours

Analytical Returns—Results in parts per 100,000.

	Small unit		Large unit	
	Screened and detritus-free sewage	Effluent	Sedi-mentation tank liquor	Effluent
Four hours oxygen absorption at 26·7° C.	4·31	1·02	3·90	1·07
Three minutes oxygen absorption—				
Before incubation	1·57	·22	1·43	·25
After incubation	—	·20	—	·23
Putrescibility	—	4/329	—	35/353
Ammoniacal nitrogen	1·77	1·72	1·89	1·83
Albuminoid nitrogen	·53	·135	·49	·15
Nitrous nitrogen	—	trace	—	trace
Nitric nitrogen	—	·07	—	·06
Bio-chemical oxygen demand (†Royal Commission Test) ..	14·69	1·00	12·68	1·15
Suspended solids	19·4	1·43	16·1	1·53

† Standard recommended not more than 2·00 parts per 100,000.

Small Unit.

In order to effect repairs to the equipment of the settlement tank of this unit the plant was out of operation for 22 days, and for one day in consequence of a blockage in the sludge return pipe.

During the 349 days of operation a high-quality effluent was well maintained. No difficulties have arisen with respect to sludge control.

Large Unit.

The treatment of sedimentation tank effluent in this unit, instead of screened and detritus-free sewage, which was commenced on May 22nd, 1930, has been continued throughout the year.

Operation of this unit during the greater part of the year at its highest efficiency mark has not been possible owing to a slight falling-off in the volumetric efficiency of the air-compressors and also in the porosity of the diffusers.

The results obtained, however, again show that the volume of sedimentation tank liquid which can be treated by the activated-sludge process, per unit, is somewhat more than the volume of screened and detritus-free sewage, and the volume of air required for purification in terms of free air per gallon of sewage treated is appreciably less.

Power Costs.

The all-in power costs, with respect to the treatment of sewage by these units during the past year, are given below :—

Total volume of sewage and tank liquor treated (two units)	542,110,000 gallons
Average pressure air mains	5·2 lbs. sq. in.
Electrical units consumed—total	263,200
Cost per unit	0·66d.
Cost per million sewage treated	£1 6s. 8·4d.

The cost per million sewage treated includes the cost of maintaining the activity of the sludge of the small unit during 23 days' stoppage.

Northenden Sewage Works.

The Department assumed control of the Northenden Sewage Disposal Works on the extension of the City on the 1st April, 1931. The works, which are situated on the bank of the River Mersey a short distance downstream from Northenden Bridge, have an area of about 12 acres and are reached by an occupation road from Kenworthy Lane. The sewage treatment plant is a compact and well-designed unit constructed by the Bucklow Rural District Council in 1925, and designed to deal with the sewage from a population of 5,000.

The sewage reaches the works by way of an 18in. outfall sewer, and, after being screened, passes through two detritus tanks with a total capacity of 6,800 gallons, or 1/24th of the dry-weather flow, into the pump well, whence it is lifted by three 4in. oil-driven Stereophagus pumps into two continuous precipitation tanks 50ft. by 16ft. by 8ft., with a capacity of nine hours' dry weather flow (58,000 gallons). The tank effluent passes through a 12in. syphon to a dosing tank (capacity 2,694 gallons) with automatic syphon control, whence it is fed on to two circular percolating filters, each 62ft. in diameter and 6ft. deep, with a total capacity of 1,230 cubic yards. The effluent from the two filters discharges into a collecting channel and passes through a cone-shaped humus tank 16ft. deep (capacity 2,000 gallons), whence it flows by a 15in. pipe to the outlet into the brook.

During the night-time the sewage passes through a rectangular continuous flow settling tank with a capacity of 19,125 gallons on to an area of under-drained land for irrigation treatment before discharge into the brook.

Storm-water is treated in two continuous settling tanks 44ft. by 12ft. by 6ft., with a total capacity of 39,600 gallons.

The sludge from the precipitation tanks, night-flow tank, and the storm-water tanks, together with the sludge and detritus from the screens and detritus tanks, gravitates to a sludge well, whence it is lifted by two 3in. Stereophagus pumps on to 6 under-drained sludge lagoons with a total area of 316 square yards. The lagoons consist of earthen banks enclosing beds of clinker with a depth of 12in., and are fed by wooden troughing. Here the sludge is air-dried and is readily taken away by the local farmers.

By means of a Lea recorder temporarily installed during the summer months the dry-weather flow of sewage was ascertained to be 215,000 gallons per day. In February, 1932, on completion of the Northenden intercepting sewer, the daily dry-weather flow was reduced to about 100,000 gallons by the diversion of approximately one-half the total sewage flow to the Davyhulme Works via the Eastern intercepting sewer, the Mersey syphon, and the Barlow Moor road sewer.

Throughout the year the precipitation tanks and percolating filters have yielded satisfactory results, as will be seen from the following summary of average analytical returns :—

Parts per 100,000.

	Raw Sewage	Tank Effluent	Final Effluent
Four hours oxygen absorption ..	6·07	3·65	0·74
Ammoniacal nitrogen	1·90	2·00	0·30
Albuminoid nitrogen	0·63	0·385	0·08
Putrescibility	—	—	0/19
Biochemical oxygen demand	—	—	0·77
Suspended solids	16·1	6·4	3·0
Percentage purification of raw sewage as measured by—			
(*a*) Four hours oxygen absorption test	—	—	88%
(*b*) Albuminoid nitrogen test ..	—	—	87%

Details of the operations cost are given in Table III.

Control of Flood Gate.

The effluent from the Northenden Sewage Works discharges by three outlets into a small brook, which passes in culvert through the river bank into the River Mersey. The wooden flood gate covering the culvert did not function efficiently when the Department took charge of the sewage works in April, 1931, allowing river water at times of flood to back up into the brook and thence by way of the effluent outlets to the sewage treatment plant. Control of this flood gate being thus vital to the Rivers Department's operations, the Wythenshawe Estate Special Committee were approached and have now transferred to the Rivers Department full and permanent responsibility for the control and upkeep of the culvert and flood gate.

Raising of River Banks.

The Department has a frontage of about 80 yards on the bank of the River Mersey. In order to give additional protection to other lands belonging to the Corporation, after a recent abnormal flood in the river, the Wythenshawe Estate Special Committee raised the earthen banks by a few inches, and the Rivers Department refunded a proportion of the cost to cover the Northenden Sewage Works frontage.

HEYHEAD SEWAGE TREATMENT INSTALLATION.

In addition to the Northenden Sewage Works, a small plant for the treatment of the sink and bath waste from a colony of newly-built dwelling-houses was taken over from the Bucklow Rural District Council on the 1st April, 1931. This plant is situated at Heyhead, Northen Etchells, near the southernmost boundary of the extended City. It consists of a cement-covered brickwork tank 6ft. by 4ft. 6in. by 5ft. deep, in which the waste water is received and from which, after settlement, the effluent is passed over four clinker filters 3ft. by 2ft. 3in., arranged for downward and upward flow, and thence discharged into a small brook close by. No trouble has been experienced with this isolated plant during the year, and it is hoped that merely nominal maintenance charges will be sufficient to keep it in proper working order until such time as the main drainage system, now in progress of construction, is extended to the Heyhead district.

MOSS SIDE SEWAGE WORKS.

The storm-water overflow at these works came into operation on 70 occasions during the year, and the average depth measured over a 6ft. cill was $9\frac{1}{4}$ inches.

The total amount of semi-dried sludge removed from the storm-water lagoons was 60 cubic yards.

The River Mersey overflow channel came into operation three times during the year, causing heavy flooding by reason of the break in the Mersey bank at a point adjoining the works.

A commencement has been made by the Mersey and Irwell Catchment Board with preventative measures for the protection of land previously damaged during flood periods.

The maintenance costs are given in Table III.

GORTON SEWAGE WORKS.

As previously reported, these works are no longer in commission, but the Department has been unable to dispose of the property. The charges on these works are given in Table III.

MIDDLETON SEWAGE WORKS.

These works are retained to provide tank treatment for a certain proportion of storm-water. The sludge collected in the tanks is passed on to drainage beds, which are specially drained for the purpose.

Approximately 500 tons of semi-dried sludge have been removed from these beds during the year.

The expenditure is itemised in Table III.

Central Electricity Board.

In addition to the privileges previously granted and referred to in the section of this report dealing with the Davyhulme Sewage Works, the Central Electricity Board were granted on short notice permission under agreement to fly 132,000-volt electricity cables over the northern corner of the Middleton Sewage Works as part of their Agecroft-Chadderton line. No pylons are being erected on the Corporation land, and the privilege granted involves no interference with the normal activities of the works.

THE TREATMENT OF SEWAGE AT DAVYHULME.

Description of Works.

The original works, which came into operation early in 1894, were designed for the treatment of the sewage by chemical precipitation.

The new works for bacterial treatment of the sewage were completed in 1904 so far as to permit at that date of the whole of the dry-weather flow being dealt with in tanks and primary contact beds.

A general plan showing the arrangement of the existing works appeared in the Annual Report for the year ending March, 1923.

The sewage, as it reaches the works, passes through a system of screens and catch-pits, designed to intercept coarser floating matter and heavy detritus.

Subsequently the sewage passes through either sedimentation or open septic tanks, and, at the present time, that portion of the tank effluent not treated on the existing contact beds passes direct to the Ship Canal.

The sludge removed by tank treatment of the sewage is discharged, either by gravity or pushed by manual labour, into subway channels leading to two ejectors, from which the majority of the sludge is forced under air pressure into three storage tanks near the banks of the

Ship Canal below Barton Locks. The sludge is removed from these tanks by (*a*) gravity flow to the sludge steamer, and subsequently is deposited at sea beyond the Mersey Bar, and (*b*) pumping through the sludge main for disposal on land at Flixton and Carrington.

If required, a small proportion of the sludge may be dewatered in plate presses, and the resultant cake disposed of as a manure, either with or without subsequent drying in a rotary drying plant.

A complete description of the scheme originally sanctioned by the Local Government Board is given in the report, entitled "Treatment of Manchester Sewage," issued in July 1902, where the details of construction of the primary contact beds and storm-water beds may be found.

Subsequently permission was granted by the Board to construct the secondary beds at Bent Lanes, adjacent to the original works, instead of at Carrington and Flixton.

A general description of the construction of the secondary beds is given in the Annual Report for the year ending March, 1909.

Extension of Works.

Considerable progress has been made in the construction of the new activated sludge units since the issue of the last Annual Report.

The bulk excavation has been completed, the excavation still to be done consisting mainly of that for the remaining hoppers of the settlement tanks, the compressor house, and the surplus sludge well.

About one-half of the concrete floors and walls of the aeration tanks of the Air Diffusion Units have been constructed. This concrete has all been deposited by the second derrick of the Insley Tower referred to in the last report. The derrick has now been moved to a new position, from which it will command the remainder of the aeration tanks, and also the whole of the "Simplex" Unit.

All the 16 hoppers of the settlement tanks of Unit No. 1 have been constructed, and work is now in progress on 10 hoppers of Unit No. 2 and four of Unit No. 4.

A delay of more than six months in the construction of the settlement tanks was caused by a pocket of running sand which was encountered in excavating for one of the hoppers. A number of boreholes were sunk for the purpose of ascertaining the extent of the running sand, and it was found that so far as the site of the work was concerned it was not of large dimensions, and that it passed under the clay into which the site piling penetrated on the north side of the site near the point where the " blow " occurred. It was accordingly decided to drive the site piling down by adding additional sheet piles alternately 10ft. and 15ft. long to the tops of the original piles over a length of about 60ft., and when this had been done and work resumed it was ascertained that the method adopted had been quite effective in cutting off the supply of water to the running sand.

Provision was made in the original design for carrying the concrete foundations of the aeration tanks down to solid ground at the N.W. corner where wet sand was known to occur. On commencing this portion of the work it was found that the sand reached in places to a lower level than had been revealed by the boreholes originally sunk, and a series of extra boreholes was put down in this area to enable detailed information relating to the ground to be obtained. As the result of these, it was decided to substitute reinforced concrete piles cast in situ on the " Vibro " system for the mass concrete foundations. These piles, numbering 271, and averaging in length 38ft. 3ins., have now been driven. The piles will have, in addition to bearing the weight of the tanks when full, to resist the tendency for the subsoil water to raise the floors of the tanks when the latter are empty. The floors will be constructed of concrete doubly reinforced so as to be capable of resisting either upward or downward resultant pressures.

The effluent channel from the new works to the culvert discharging into the Ship Canal has been constructed.

Other work at present in progress includes the construction of the new approach road, a portion of the feed channel from the existing settlement tanks to the activated sludge units, and the aeration tank of the Bio-Aeration Unit.

The total amount expended on the extension scheme to date is £235,513, including £93,543 in respect of the new Activated Sludge Units.

Power Supply.

The steam plant was displaced in September, 1923, and since February 2nd, 1924, the works have been supplied with current by the Corporation Electricity Department by direct cable from the Barton Power Station at a pressure of 6,600 volts to two 250 K.V.A. transformers, where it is stepped down to 440 volts for power and 220 volts for lighting purposes.

Panel switch-boards, complete with main cut-outs and meters, are provided for both high and low tension current.

The motors throughout the works are designed for 3-phase, 50 cycle alternating current, and have a total working output of 500 B.H.P.

There are two 60 B.H.P. motors for driving Alley-McLellan air compressors (high pressure) for operating sludge ejectors and sludge presses; two 47 B.H.P. motors driving two 10in. Gwynne "Invincible" pumps, each capable of delivering 2,500 gallons per minute against a 40 foot head, employed for pumping off top water from sedimentation and septic tanks prior to removal of sludge; one 35 B.H.P. motor driving the new activated-sludge compressor and three 30 B.H.P. motors for driving three Reavell air compressors (low pressure) intermittently employed in connection with the activated sludge plant; one 30 B.H.P. motor driving a Ruggles-Coles dryer, and one 24 B.H.P. motor also used in connection with sludge drying; one 20 B.H.P. motor used for driving purposes in the fitting shop; two 20 B.H.P. motors for operating sewage screens and elevators; two 10 B.H.P. motors for operating the two clinker washing plants; and small motors from 1·5 to 10 B.H.P. used for sundry other purposes, including the operation of the screens in the new screening chamber.

Drainage of the Parish of Davyhulme.

Some time ago an agreement was entered into with the Barton Rural District Council to treat the sewage from the Davyhulme Parish at the Davyhulme Works.

The sewage contributed by the population in Crofts Bank Road, Barton Road (part of), Davyhulme Road, and Bent Lanes is discharged at two points—*i.e.*, Point "C" and Point "E." That discharged at Point "C" passes over shallow filter beds, and then into the feed channel to the secondary beds.

The sewage delivered at Point "E" is conveyed by means of a 2ft. diameter brick sewer, on which a storm-water overflow is fixed at the Bent Lanes Brook, and which is intended to limit the volume of sewage passed on the estate of the Corporation. The sewage is delivered into a manhole referred to in the Agreement as Point "E," and from which it gravitates through three 6in. diameter cast-iron pipes to a "recorder chamber," where the flow is measured by means of a "V" notch of the type designed by Messrs. Lea, of Manchester, and has a maximum recording capacity of 10,000 gallons per hour. After passing over the notch the sewage flows on to pneumatic ejectors of 200 gallons capacity, in duplicate, each fixed in cast-iron tubbing. These ejectors raise the sewage by means of compressed air, supplied from the main engine house at the works, into the main sewage channel. Arrangements are well advanced for the replacement of these ejectors by an electrically-driven centrifugal pump, whereby economy should be effected in pumping costs.

Area of Land.

The total area of land comprising the Davyhulme Works amounts to 254·0 acres, and is divided up as follows :—

	Acres
Land occupied by storm-water, detritus, open septic tanks, and activated-sludge plant	15·0
Land occupied by buildings, sludge tanks, etc., and land occupied in connection therewith	15·0
Land occupied as wharves, lay-byes, and storage	5·0
Land occupied by first contact bacteria beds..	46·0
Land occupied by second contact bacteria beds	39·0
Land occupied by disused storm-water filters..	26·8
The area of land not occupied by bacteria beds, buildings, tanks, etc., but includes existing roads, railway and embankments, and disused river bed	107·2
Grand total	254·0

Tenancies, etc., of Land.

During the year covered by this report, the Rivers Committee's lands at Carrington and Flixton have been supervised from the Central Office as heretofore. The large holding at Carrington has fallen vacant, but, contrary to the first intention, one of the retiring joint tenants has been allowed to retain occupation, as the land will not be required for sludge disposal purposes for some time to come. No other changes have taken place during the year.

The whole of the Flixton lands in the River Mersey meadows continue to be utilised by the Department either for grass crops or for sludge disposal operations.

The total area let to farmers, etc., at the date of this report was approximately as follows, viz. :—

	Area				Annual Rental		
	a.	r.	p.		£	s.	d.
Townships of Stretford and Davyhulme	11	0	1	..	18	13	11
Township of Carrington ..	89	3	10½	..	108	15	10
Township of Flixton	65	2	2	..	125	17	10
Totals	166	1	13½	..	£253	7	7

Central Electricity Board.

The arrangements of the Central Electricity Board detailed in the Report for the year ended 26th March, 1930, have become effective, with one minor alteration, and high tension power cables (132,000-volt.) forming part of the Barton—Warrington line of the North-West England and North Wales Electricity scheme are now flying over the Committee's lands at Davyhulme, Flixton, and Carrington, and lattice-work pylons for sustaining the wires have been erected by the Board at the agreed points. Where the cables fly across the entrance roadway to the Davyhulme Sewage Works (Rivers Lane) the Post Office authorities have placed their public telephone lines underground, and at the request of the Department have also grounded the private telephone lines of the Corporation and of the circuit connecting with the sewage flow recorder station in Trafford Park. It has not been considered necessary to place the private lighting circuit underground.

Proposed transfer of land to Electricity Department.

Preliminary discussions have taken place with the Electricity Committee regarding the possible transfer to that Committee of a plot of land belonging to the Rivers Department in Carrington, for the purpose of the erection thereon of an electricity generating station in connection with the Central Electricity Board's scheme referred to in the previous paragraph.

River Mersey Banks.

The maintenance of the banks of the River Mersey, where it flows by the Committee's land at Carrington and Flixton, has proved less costly than last year, an amount of £537 10s. having been spent. Only absolutely essential work has been undertaken, particularly in view of the up-stream operations of the Rivers Mersey and Irwell Catchment Board.

Diagram of Sewage Treatment Operations.

A diagram of the treatment operations at the Davyhulme Sewage Works is appended to this Report. This is a copy of the diagram prepared more especially for the benefit of non-technical visitors.

Volume of Sewage Treated.

The volume of sewage delivered at the works from March 26th, 1931, to March 31st, 1932 (inclusive), including 57,197,000 gallons from the Parish of Davyhulme, was 19,521,554,000 gallons.

The average daily flow of sewage was 52,477,000 gallons, showing an increase on the previous year of 3,378,000 gallons, or 6·9 per cent.

The average daily flow of sewage per head of population has ranged from a minimum of 46 gallons for the week ending July 1st, 1931, to a maximum of 136 gallons for the week ending August 19th, 1931.

Sewage Flow and Rainfall.

WEEK ENDING	Sewage flow			Rainfall			
	TOTAL	Average daily flow		Davy-hulme	Oldham Road	Platt Fields	Heaton Park
	Gallons	Gallons	Gallons per head	Inches	Inches	Inches	Inches
1931							
April 1st	259,710,000	37,101,000					
8th	408,641,000	58,377,000		2·08	2·41	2·15	2·50
15th	345,670,000	49,381,000					
22nd	336,151,000	48,022,000					
29th	387,303,000	55,329,000					
May 6th	302,621,000	43,232,000		2·09	2·09	2·37	1·99
13th	298,416,000	42,631,000					
20th	366,375,000	52,339,000					
27th	379,292,000	54,185,000					
June 3rd	387,767,000	55,395,000		6·02	6·00	5·84	6·17
10th	516,784,000	73,826,000					
17th	410,117,000	58,588,000					
24th	389,468,000	55,638,000					
July 1st	248,295,000	35,471,000		2·78	2·85	2·57	4·43
8th	351,671,000	50,239,000					
15th	358,893,000	51,270,000					
22nd	343,774,000	49,111,000					
29th	318,084,000	45,441,000		4·61	4·78	4·38	4·64
August 5th	398,303,000	56,900,000					
12th	462,392,000	66,056,000					
19th	737,046,000	105,292,000					
26th	455,183,000	65,026,000		6·08	7·50	6·53	6·52
September 2nd ..	331,210,000	47,316,000					
9th ..	484,132,000	69,162,000					
16th ..	351,092,000	50,156,000					
23rd ..	291,826,000	41,689,000		1·70	1·84	1·67	1·90
30th ..	274,971,000	39,282,000					
October 7th	319,358.000	45,623,000					
14th	267,842,000	38,263,000					
21st	261,260,000	37,323,000		2·29	2·31	1·89	3·04
28th	277,432,000	39,633,000					
November 4th.. ..	459,436,000	65,634,000					
11th ..	435,716,000	62,245,000					
18th ..	489,407,000	69,915,000		4·78	4·62	4·49	5·09
25th ..	395,902,000	56,557,000					
December 2nd ..	536,151,000	76,593,000					
9th ..	408,173,000	58,310,000					
16th ..	305,279,000	43,611,000		1·90	1·84	1·13	1·91
23rd ..	292,916,000	41,845,000					
30th ..	326,384,000	46,626,000					
1932							
January 6th	611,824,000	87,403,000					
13th	456,223,000	65,175,000		3·53	3·83	3·32	4·48
20th	341,287.000	48.755,000					
27th	291,451,000	41,636,000					
February 3rd	292,138,000	41,734,000					
10th ..	299,739,000	42,677,000		0·17	·15	·13	·12
17th ..	287,099,000	41,014,000					
24th ..	285,460,000	40,780,000					
March 2nd	290,333,000	41,476,000					
9th	333,962,000	47,709,000		0·94	2·19	2·06	2·71
16th	293,015,000	41,859,000					
23rd	335,459,000	47,923,000					
31st (8 days).	433,122,000	54,140,000		.. 0·92			
Total for 372 days..	19,521,554,000	52,477,000	68	39·89	42·41	38·53	45·50
Total for 364 days ending 25th March, 1931	17,872,074,000	49,099,000	63	39·75	40·93	40·03	46·10

The number of days on which a measurable fall of rain (·01 inch or over) occurred during the 52 weeks was as follows :—

Davyhulme	172 days
Oldham Road	191 ,,
Platt Fields	181 ,,
Heaton Park	190 ,,

During the ten years following the completion of the plant for the bacterial treatment of the City sewage, 179,930 pail closets were converted to the water carriage system, and during the succeeding eighteen years a further 1,250, there being now comparatively few houses unconverted.

The following average analytical returns (stated in parts per 100,000) indicate the strength of the sewage received during the year as compared with the preceding one :—

	Year Ending	
	March, 1931	March, 1932
Four hours oxygen absorption at 26·7° C	11·04	11·37
Ammoniacal nitrogen	2·31	2·57
Albuminoid nitrogen	0·635	0·65
Combined chlorine	17·8	19·6
Suspended solids—mineral	8·1	8·1
,, ,, organic	14·9	15·4
,, ,, total	23·0	23·5
Biochemical oxygen demand	—	*18·0

* Six months average only.

Davyhulme Parish Sewage.

It is estimated that during the period under review a total volume of 57,197,000 gallons of sewage has been received at Point " E " from the Parish of Davyhulme at an average rate of 153,800 gallons per day. The character of this sewage is indicated by the following average analytical returns for this and the preceding year :—

Results stated in parts per 100,000	Year Ending	
	March, 1931	March, 1932
Four hours oxygen absorption at 26·7°. C ..	5·63	5·51
Ammoniacal nitrogen	2·54	2·40
Albuminoid nitrogen	0·53	0·51
Combined chlorine	5·8	5·3
Suspended solids (total)	12·0	13·0

Detritus Tanks and Screens.

A full description of the new plant was given in the Annual Report for the year ending March, 1929.

The re-wiring of the screens, referred to in the last report, has been successful in reducing very considerably maintenance costs. Experience with these new types of wire rope suggests that they are more suitable for this purpose than the ropes originally employed. No serious defects, such as "bird-caging," have been manifest during the eighteen months they have been in use.

A total of 770 tons of detritus and screen refuse has been removed in the old screening chamber (No. 1), whilst 20,856 tons of material have been removed from the new detritus tanks, and 1,675 tons of refuse have been taken out by the new screens (No. 2 chamber).

Sludge Disposal.

The total sludge production during the year was 209,015 tons, which is equal to 10·71 tons per million gallons sewage treated. Of this amount 151,779 tons were sent out to sea, 30,809 tons were pumped to Flixton and deposited on land, and 26,427 tons of water or thin sludge were decanted from the sludge storage tanks (prior to loading the steamer) and discharged on to drainage beds.

During the year the sludge steamer "Joseph Thompson" made 167 voyages, an average of 3·14 trips per week. The total mileage covered was 21,042 (statute), an average of 396 miles per week. The total coal consumption was 1,914 tons, an average of 11·46 tons per trip.

The sludge dealt with on the land area at Flixton amounted to 30,809 tons, as compared with 22,724 tons so disposed of during the preceding year. The method of broadcasting the sludge on lightly ploughed land has been retained, with final incorporation of the sludge into the soil by subsequent ploughing.

Steady progress has been made with the drainage of this land, and the advantage of this work has been demonstrated during the year on one plot, the drainage of which has been completed.

Particulars of the cost of sludge disposal are given in Table IV.

Treatment of the Sewage in Sedimentation Tanks.

The six tanks referred to in the report for the year ending March, 1917, have been in operation as sedimentation tanks throughout the 12 months under observation.

The total flow through these tanks (water-holding capacity, 7,125,000 gallons) during the year amounted to 11,577,087,000 gallons, or 31,121,000 gallons per day, which is equal to 59 per cent. of the total sewage flow. The effluent from these tanks constitutes practically the whole of the unfiltered sewage which at the present time is passed to the Canal without further treatment. The character of this discharge is indicated by the following average analytical returns for this and the preceding year.

Results in parts per 100,000	Year Ending	
	March, 1931	March, 1932
Four hours oxygen absorption at 26·7° C. ..	9·02	8·90
Ammoniacal nitrogen	2·33	2·59
Albuminoid nitrogen	0·525	0·495
Combined chlorine	16·5	17·8
Suspended solids—mineral	5·0	4·2
,, ,, organic	8·4	7·2
,, ,, total	13·4	11·4

In the following table particulars are given of the amount and character of the sludge removed from the individual tanks :—

Tank No.	Sludge Tons	Per cent. Water
6	21,777	89·2
7	23,206	88·5
8	23,184	88·3
9	24,810	87·7
10	29,905	88·3
11	18,424	88·8

The total quantity of sludge removed from the sedimentation tanks was 141,306 tons, or 12·2 tons per million gallons treated. The amount of sludge removed from these tanks is equal to 68 per cent. of the total tank sludge production.

Treatment of the Sewage in Open Septic Tanks and Bacteria Beds.

There are now 10 tanks in operation as open septic tanks. The length of each tank is 300 feet, and the width and depth of five of the tanks is 100 feet and 6 feet (average) respectively ; the other four tanks are shallower, but of greater width, while No. 12 tank (a portion of which is occupied by the activated-sludge unit) is now only 66 feet wide.

The total holding capacity of the 10 tanks is about 12,000,000 gallons.

The total volume of sewage passed through these tanks and dealt with by the primary contact beds and by the activated-sludge process during the year amounted to 7,944,467,000 gallons, or 41 per cent. of the total flow of sewage.

Of the total quantity thus dealt with, 6,233,250,000 gallons were treated on the secondary filter beds. This volume is equal to 79 per cent. of the primary effluent, or 32 per cent. of the total sewage flow.

In the following table are given details of the amount and character of the sludge removed from the various tanks :—

Tank No.	Sludge Tons	Per cent. Water
1	3,693	90·4
2	5,495	89·1
3	9,417	89·2
4	10,677	90·1
5	4,041	88·6
12	6,074	92·4
13	3,187	90·6
14	6,070	90·3
15	3,507	90·3
16	4,478	89·6

The total quantity of sludge removed from the septic tanks was 56,639 tons, an average of 7·1 tons per million gallons.

Half-acre Primary Beds.

This filtration area consists of 92 half-acre beds, divided into two sections of 40 beds each (Series I. and III.) and one of 12 beds (Series II.). A total volume of 7,721,309,000 gallons of tank effluent has been dealt with during the year at an average rate of 451,000 gallons per acre per day, or 84 gallons per cubic yard per day, as compared with last year's figure of 475,000 gallons per acre per day, or 88 gallons per cubic yard per day. The quantities of tank effluent dealt with by the individual sections with comparative figures for the previous year are as follows :—

		Quantities dealt with (gallons)			
		Total	Per day	Per acre per day	Per cubic yard per day
Series I.	1931 ..	3,698,380,000	10,160,000	508,000	94
	1932 ..	3,273,327,000	8,799,000	440,000	81
Series II.	1931 ..	1,008,750,000	2,771,000	462,000	86
	1932 ..	1,099,485,000	2,956,000	493,000	91
Series III.	1931 ..	3,246,215,000	8,918,000	446,000	83
	1932 ..	3,348,497,000	9,001,000	450,000	83

The quality of the effluents obtained from the various sections may be judged from the following average analytical returns stated in parts per 100,000 :—

	Septic Tanks 1-5	Series I	Series II	Septic Tanks 12-16	Series III
Four hours oxygen absorption at 26·7° C. ..	9·31	4·06	3·74	8·30	3·37
Ammoniacal nitrogen ..	2·72	1·79	1·75	2·63	1·91
Albuminoid nitrogen ..	0·52	0·225	0·215	0·465	0·205
Nitrous nitrogen	—	0·02	0·015	—	0·015
Nitric nitrogen	—	0·22	0·25	—	0·21
Combined chlorine	18·7	16·4	16·4	17·0	15·7
Three minutes oxygen absorption before incubation	3·80	1·73	1·63	3·42	1·39
Three minutes oxygen absorption after incubation	—	2·18	1·99	—	1·68
Putrescibility	—	27½/53	25/53	—	17½/52
Suspended solids—					
mineral	4·1	2·0	1·9	3·6	1·7
organic	7·2	3·2	2·8	5·6	2·9
total	11·3	5·2	4·7	9·2	4·6

The purifications effected by the various sections of the area based on the results of the four hours oxygen absorption and albuminoid nitrogen tests, together with comparative figures for the year ending March 25th, 1931, are as follows :—

		Series I		Series II		Series III	
		1931	1932	1931	1932	1931	1932
4 hours oxygen absorption test	Calculated on raw sewage	59	64	65	67	71	70
	Calculated on tank effluent	54	56	61	60	58	59
Albuminoid nitrogen test	Calculated on raw sewage	65	65	70	67	67	68
	Calculated on tank effluent	52	57	60	59	55	56

During the year under observation the washing, rescreening, and replacement of the media of 11 beds has been completed and the beds placed again in commission. These beds have been in operation for periods varying from 8 years 1 month to 8 years 11 months, and have received from 7,500 to 9,800 fillings meanwhile. The renewal of four more beds will shortly be completed, and this will mark the end of the present cycle of primary bed renewal work. At the end of the period under review the oldest bed had received only 4,475 fillings, although nearly seven years have elapsed since its previous renewal and since the beds are in excellent physical condition an immediate resumption of these operations is not called for.

Advantage is being taken of these circumstances to commence renewal operations on the secondary contact bed area, which work is overdue.

The operating, maintenance and renewal costs are summarised in Table IV.

Secondary Contact Beds.

During the summer months these beds receive 21 fillings per week for three weeks, and rest completely on the fourth one in order to gain the maximum value from the rest period during the drier part of the year. In winter the rest week is dispensed with and one day per week allowed instead. A careful examination of these beds has shown clearly that many of them are reaching the end of their useful service after more than 20 years' operation. It has therefore been decided to remove and wash the material and remake the beds as far as is necessary. A washing plant is under construction adjacent to the site and operations will shortly commence. In the meantime a portion of the media is being removed from bed No. 18 and dealt with on the existing washing plant in the yard, the clean media being used to complete the refilling of the primary beds.

During the year under review the second contact beds have dealt with a total flow of 6,233,250,000 gallons, which is equivalent to 79% of the primary effluent, or 32% of the total sewage flow.

Experimental Half-acre Bed No. 10a.

This bed, after having been in commission for 27 years, was stopped on the 22nd February, 1932, on account of the renewal operations which are pending. The bed is to be used for the disposal of the slurry resulting from the media washing operations, and as its renewal will probably be the last to be completed, it is unlikely to be in operation again for at least 18 months.

During the portion of the year when the bed was in operation it dealt with 59,175,000 gallons of primary effluent at an average rate (including all normal resting periods) of 177,000 gallons per day, or 89 gallons per cubic yard per day as compared with last year's figures of 174,000 gallons per day and 87 gallons per cubic yard per day. The quality of the effluents obtained is indicated in the following summary of analytical returns for this and the preceding year :—

Results stated in parts per 100,000	Year Ending	
	March, 1931	March, 1932
Four hours oxygen absorption at 26·7° C. ..	2·22	2·21
Ammoniacal nitrogen	1·02	1·16
Albuminoid nitrogen	0·135	0·14
Nitrous nitrogen	·02	0·025
Nitric nitrogen	·83	0·81
Combined chlorine	15·7	17·1
Putrescibility	1/44	0/40
Suspended solids (total)	2·4	2·5
Biochemical oxygen demand	2·64	2·34
Purification effected on primary effluent—		
(*a*) Calculated on four hours oxygen absorption test	62%	62%
(*b*) Calculated on albuminoid nitrogen test	56%	56%
Purification effected on raw sewage—		
(*a*) Calculated on four hours oxygen absorption test..	80%	81%
(*b*) Calculated on albuminoid nitrogen test	79%	78%

No. 1 Bed.

This converted percolating filter continues to be operated as a contact bed, and during the past year has dealt with 257,400,000 gallons of primary effluent at an average rate of 692,000 gallons per day, or 108 gallons per cubic yard per day as compared with last year's average daily flow of 775,000 gallons and 121 gallons per cubic yard. The character of the effluents obtained may be judged from the following average analyses for this and the preceding year :—

Results stated in parts per 100,000	Year Ending	
	March, 1931	March, 1932
Four hours oxygen absorption at 26·7° C. ..	2·82	3·02
Ammoniacal nitrogen	1·35	1·53
Albuminoid nitrogen	0·165	0·18
Nitrous nitrogen	0·02	0·025
Nitric nitrogen	0·57	0·60
Combined chlorine	16·2	18·2
Putrescibility	6/82	4/87
Suspended solids (total)..	2·3	2·7
Biochemical oxygen demand..	3·47	2·71
Purification effected on primary effluent calculated on—		
(*a*) Four hours oxygen absorption test	47%	46%
(*b*) Albuminoid nitrogen test	44%	43%
Purification effected on raw sewage calculated on—		
(*a*) Four hours oxygen absorption test	74%	73%
(*b*) Albuminoid nitrogen test	74%	72%

Second Contact Beds Nos. 2 to 39.

The details of the construction of these beds are given in the Annual Report for the year ending March, 1909. The usual maintenance attention has been given to the surface of these beds, the cost of which is given in Table IV. The quantities of primary effluent treated on the various sections of this filtration area, together with the results of analyses of the filtrates obtained during this and the preceding year, are as follows :—

Beds 5 to 19.

	Year Ending	
	March, 1931	March, 1932
Total volume treated	2,243,262,000	2,045,050,000
Average volume treated per day	6,163,000	5,497,000
Average volume treated per cubic yard per day..	102	91
Analytical Results (parts per 100,000).		
Four hours oxygen absorption at 26·7° C...	2·26	2·46
Ammoniacal nitrogen	1·21	1·33
Albuminoid nitrogen	0·135	0·145
Nitrous nitrogen	0·015	0·02
Nitric nitrogen	0·65	0·65
Combined chlorine	16·0	17·4
Putrescibility	5½/97	4½/101
Suspended solids (total)	2·7	2·9
Biochemical oxygen demand	2·30	2·05
Purification effected on primary effluent calculated on—		
(*a*) Four hours oxygen absorption test	58%	56%
(*b*) Albuminoid nitrogen test ..	54%	54%
Purification effected on raw sewage calculated on—		
(*a*) Four hours oxygen absorption test	80%	78%
(*b*) Albuminoid nitrogen test ..	79%	78%

Beds 2 and 20 to 27.

	Year Ending	
	March, 1931	March, 1932
Total volume treated	1,125,361,000	1,144,640,000
Average volume treated per day	3,092,000	3,077,000
Average volume treated per cubic yard per day	94	93
Analytical Results (parts per 100,000)		
Four hours oxygen absorption at 26·7° C. .	2·54	2·79
Ammoniacal nitrogen	1·27	1·42
Albuminoid nitrogen	0·155	0·165
Nitrous nitrogen	0·02	0·025
Nitric nitrogen	0·63	0·63
Combined chlorine	16·2	18·3
Putrescibility	8½/96	2/101
Suspended solids (total)	2·7	2·9
Biochemical oxygen demand	2·75	2·44
Purification effected on primary effluent calculated on—		
(*a*) Four hours oxygen absorption test	53%	50%
(*b*) Albuminoid nitrogen test ..	47%	48%
Purification effected on raw sewage calculated on—		
(*a*) Four hours oxygen absorption test	77%	75%
(*b*) Albuminoid nitrogen test ..	76%	75%

Beds 32 to 35.

	Year Ending	
	March, 1931	March, 1932
Total volume treated	781,260,000	685,800,000
Average volume treated per day	2,146,000	1,844,000
Average volume treated per cubic yard per day	87	75
Analytical Results (parts per 100,000).		
Four hours oxygen absorption at 26·7° C..	2·34	2·73
Ammoniacal nitrogen	0·93	1·13
Albuminoid nitrogen	0·135	0·16
Nitrous nitrogen	0·015	0·025
Nitric nitrogen	0·84	0·91
Combined chlorine	14·7	17·1
Putrescibility	0/41	0/40
Suspended solids (total)	2·9	2·8
Biochemical oxygen demand	2·71	2·88
Purification effected on primary effluent calculated on—		
(*a*) Four hours oxygen absorption test	60%	53%
(*b*) Albuminoid nitrogen test ..	56%	50%
Purification effected on raw sewage calculated on—		
(*a*) Four hours oxygen absorption test	79%	76%
(*b*) Albuminoid nitrogen test ..	79%	75%

Beds 36 to 39.

	Year Ending	
	March, 1931	March, 1932
Total volume treated	778,980,000	789,300,000
Average volume treated per day	2,140,000	2,122,000
Average volume treated per cubic yard per day	94	93
Analytical Results (parts per 100,000).		
Four hours oxygen absorption at 26·7° C. .	2·37	2·72
Ammoniacal nitrogen	0·85	1·18
Albuminoid nitrogen	0·135	0·16
Nitrous nitrogen	0·015	0·025
Nitric nitrogen	0·91	0·84
Combined chlorine	15·6	16·8
Putrescibility	0/42	0/46
Suspended solids (total)	2·9	2·8
Biochemical oxygen demand	2·71	2·88
Purification effected on primary effluent calculated on—		
(*a*) Four hours oxygen absorption test	59%	53%
(*b*) Albuminoid nitrogen test . .	56%	50%
Purification effected on raw sewage calculated on—		
(*a*) Four hours oxygen absorption test	79%	76%
(*b*) Albuminoid nitrogen test . .	79%	75%

Demonstration Activated Sludge Plant.

Apart from periodic stoppages to allow of the cleansing of the preliminary sedimentation tank, this plant has been in continuous operation throughout the period under review, dealing with sewage freed from the bulk of settleable solids.

A total volume of 223,158,000 gallons of sewage has been dealt with, at an average rate of 628,600 gallons per working day, with an air consumption of 1·41 cubic feet of free air per gallon, and an average detention period (aeration and re-aeration) of 6·5 hours.

The results of treatment are shown by the following average analytical returns expressed in parts per 100,000 :—

	Raw sewage	Settled sewage	Effluent
Four hours oxygen absorption at 26·7° C.	10·57	8·46	2·49
Ammoniacal nitrogen	2·79	2·86	2·27
Albuminoid nitrogen	0·64	0·525	0·165
Nitrous and nitric nitrogen	—	—	0·115
Putrescibility	—	—	15/355
Suspended solids (total)	20·9	9·7	3·1
Biochemical oxygen demand	*18·02	*14·83	1·53

* Six months average only.

Purification effected on settled sewage calculated on :—

(*a*) Four hours oxygen absorption test .. .. .. 70·6 %

(*b*) Albuminoid nitrogen test .. .. 68·6 %

(*c*) Biochemical oxygen demand .. .. 89·7 %

Purification effected on raw sewage, calculated on :—

(*a*) Four hours oxygen absorption test .. .. .. 76·4 %

(*b*) Albuminoid nitrogen test .. .. 74·2 %

(*c*) Biochemical oxygen demand .. .. 91·5 %

Summary of Results (Davyhulme Works).

The following summary of the results of operation of the Davyhulme Works is submitted :—

Total sewage flow—
Main outfall .. 19,464,357,000
Davyhulme Parish, Point "E," 57,197,000 } = 19,521,554,000 gallons.
Total sludge removed .. .. .. = 209,015 tons.
= 10·71 tons per million gallons.
Total volume of sewage filtered (primary contact beds) .. .. = 7,721,309,000 gallons.
= 39·5% of the total sewage flow.
Volume of sewage treated by the activated-sludge process .. .. = 223,158,000 gallons.
= 1·1% of the total sewage flow.
Total volume filtered by secondary beds .. .. = 6,233,250,000 gallons.
= 79% of the primary effluent.
= 32% of the total sewage flow.

Total Revenue Cost (apart from Interest Charges and Repayment of Debt) :—

= £2 16s. 5·9d. per million gallons.

Average Cost per Head of Population—

	s.	d.
For year ending 31st March, 1932	= 1	5·1
For ten years ending 31st March, 1932	= 1	7·1

Results of Treatment (expressed in parts per 100,000).

Four hours oxygen absorption at 26·7° C.			Albuminoid nitrogen		
Raw sewage	Average effluent, including unfiltered tank effluent	Percentage purification	Raw sewage	Average effluent, including unfiltered tank effluent	Percentage purification
11·37	6·23	45%	0·65	·35	46%

In Table VI. will be found particulars of the cost of sewage treatment at Davyhulme for the period 1896-1932, including the total outlay on sewage disposal works up to date, annual maintenance, and annual capital charge (payment of interest and repayment of debt), which has been estimated on the basis of 5 per cent. of the outlay to date. The costs are also given in terms of the amount per head of population. The percentage purification effected by the treatment of sewage during the different years is also shown, together with the estimated population connected to the sewers.

Research Work.

Research work during the year has been directed to the further study of the problem of the secondary digestion of sludge.

In the appendix to this Report is given (*a*) a summary of additional laboratory experiments on the separate fermentation of paper, grease, and fæcal matter, with special reference to observed differences due to the temperature employed during digestion, and (*b*) a summary of the information gained by the continuous operation during the year of the demonstration sludge digestion units at the Davyhulme Works, which were described (accompanied by plans and photographs) in the appendix to last year's Report. This plant was designed by the Resident Chemist along the lines adopted by Buswell in his experimental work, and is under the control of the Research Chemist, assisted by A. Bradwell, A.M.C.T., and R. Hicks, A.R.T.C., whilst E. E. Jones, M.SC., has assisted in the laboratory research work at the Withington Works. The whole of the technical work of the Department is subject to the direction of the Consulting Chemist.

Ship Canal Water.

The results of the incubation test as applied to the canal water taken above the Work's outfall, together with a record of rainfall and air temperature, are given in Diagram 1.

This diagram once again affords striking evidence of the influence of rainfall and air temperature on the general character of the canal water.

On the whole, the quality of the water has been good throughout the year. The incidence of the rainfall during the warm months was such as to limit to a minimum the periods during which the canal water was of a putrefactive nature. Fortunately the longest period of drought occurred in the winter (middle of January to the first week in March, 1932), when the air temperature was at its lowest, and the consequent deterioration in the quality of the canal water, as measured by the extent to which it became putrescible on incubation, was not nearly so marked as would have been the case if a corresponding drought had been experienced during the summer months.

Concluding Remarks.

It will be seen from the foregoing Report that despite serious delay, consequent on foundation difficulties, considerable progress has been made during the year with the construction of the activated-sludge plant, designed to treat upwards of one-half the dry weather flow of sewage, together with the proportionate volume of storm-water.

With regard to the future problem of sludge disposal at Davyhulme, it has been decided to retain sea disposal as the principal means of dealing with the situation when the new activated-sludge units are in commission.

In this connection a contract has quite recently been let for the supply of a new sludge steamer, to be named the S.S. "Mancunium." The carrying capacity of the new boat will be appreciably greater than that of the S.S. "Joseph Thompson" which it will replace. The S.S. "Mancunium" should be in commission within 12 months from the date of signing this Report.

The precise supplementary methods to be employed in conjunction with sea disposal and land disposal, which may possibly involve the application of secondary digestion to some proportion of the sludge, have yet to be determined.

On behalf of the Rivers Committee,

G. HAROLD WHITE,
Chairman.

19th September, 1932.

APPENDIX.

Sludge Digestion.

The work described in last year's Annual Report in respect of the secondary digestion of sewage sludge has been continued in the laboratory and on a practical scale.

Laboratory Experiments.

Comparative experiments relating to the separate digestion of (a) *paper,* (b) *grease, and* (c) *fæcal matter.*

Further experiments with regard to the separate digestion of the common components of sewage sludge, viz., (*a*) paper, (*b*) grease, and (*c*) fæcal matter have been made.

During the past year special attention has been given to the digestion of these materials at the temperature of 26° C.

The procedure adopted was similar to that used in the former experiments carried out at the temperature of 50–55° C., viz. :—

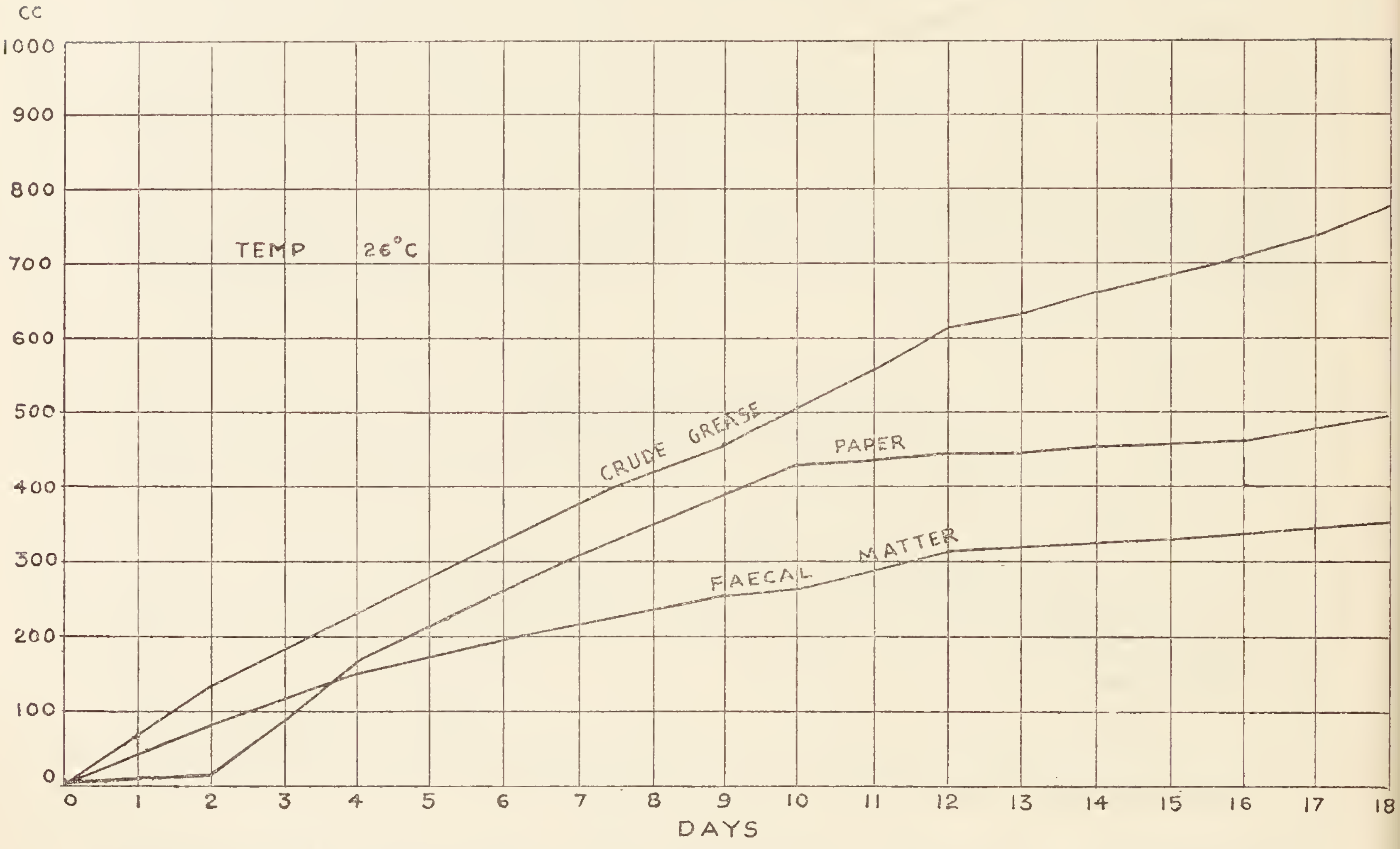
> Samples of filter paper, crude sewage grease, and fæcal matter were obtained and the proportion of dry organic matter in each determined. The weight of each required to provide 1·5 grammes of dry organic matter was calculated and this amount was weighed out in a small conical flask. The quantity of dry organic matter in a sample of digested sludge containing 94–95% of water was also determined, the weight required to provide three grammes of dry organic matter calculated and this amount added to each material. The same amount of digested sludge was also put in a fourth flask to act as a control or blank in the experiment. The flasks were placed in a thermostatic bath (26° C.), each being connected to an arrangement for collecting the gas given off during digestion in measuring cylinders over brine saturated with CO_2.
>
> The volume of gas evolved was read every 24 hours, the volume given off from the control subtracted from each of the others and the results calculated to a basis of one gramme of dry organic matter. The figures thus obtained were plotted.

A typical result is set out in Figure I.

Figure I.

Digestion of paper, grease, and fæcal matter at 26° C.

Volume (in c.c.) of gas given off per gramme of dry organic matter.

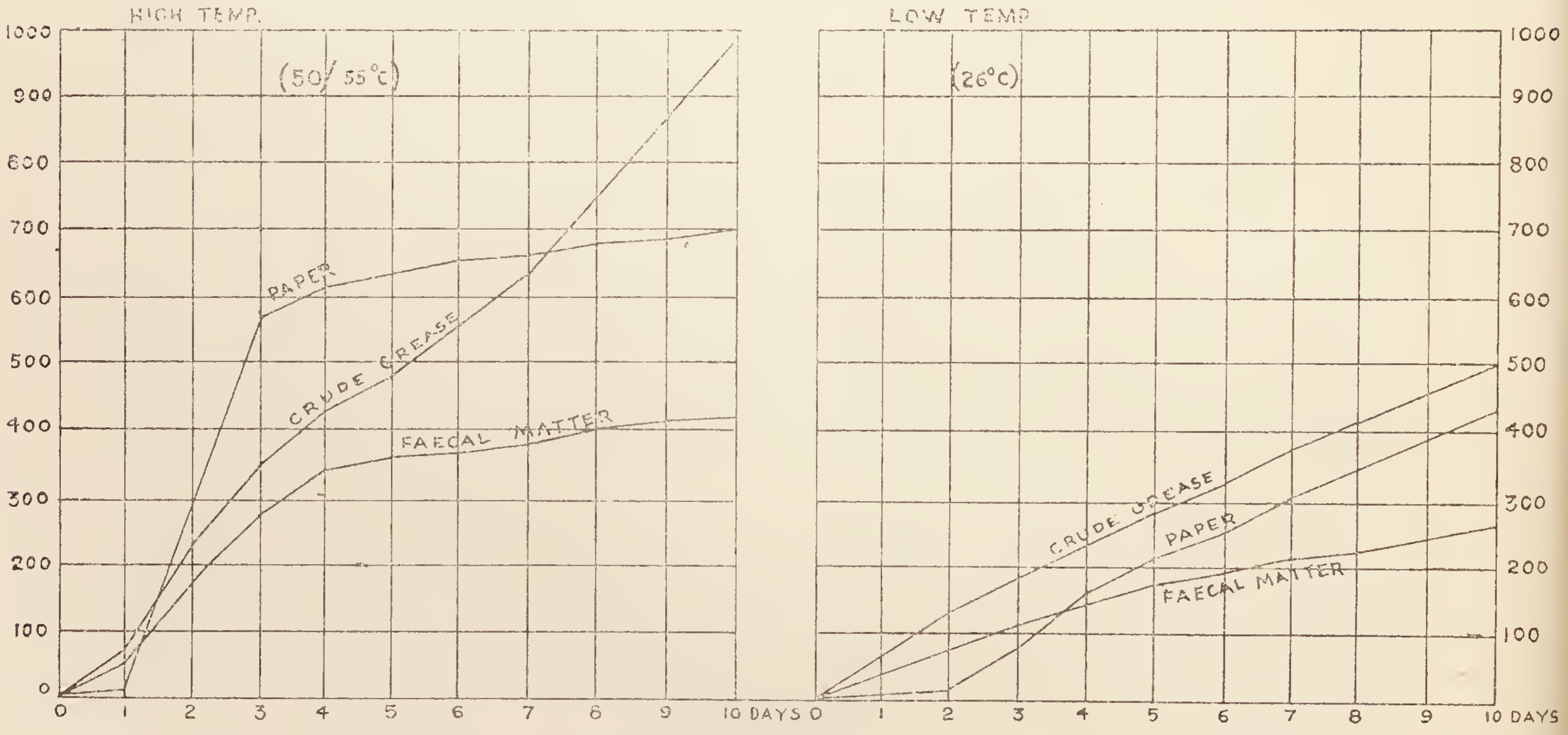


In Figure II. the results shown in Figure I. are compared with those previously obtained when using digested sludge capable of promoting active fermentation of these materials at 50–55° C.

Figure II.

Digestion of paper, grease, and fæcal matter at 50–55° C. and at 26° C.

Volume (in c.c.) of gas given off per gramme of dry organic matter.



The above results show an increase in the rate of digestion and an increase in the volume of gas produced per gramme D.O.M. at the digestion temperature of 50–55° C. as compared with the digestion temperature of 26° C.; results which are in close agreement with those of Rudolfs and others.

Also the results show that at 50–55° C. paper is more rapidly digested than grease or fæcal matter, whereas at 26° C. the grease is most rapidly digested.

It is probable that this observed difference may be to a large extent responsible for the divergent results recorded by investigators working with different sewage sludges, since sludge rich in cellulosic material would yield results showing a marked difference in favour of "thermophilic" digestion, whereas in the case of sludge poor in cellulosic material and rich in grease and/or fæcal matter the advantage of the higher temperature would not be so clearly demonstrated.

Demonstration Sludge Digestion Plant.

Digestion of sludges at 25–30° C. and at 50–55° C.

This plant, which consists essentially of two digestion tanks, each of 3,220 gallons capacity, fitted with a hot-water circulation system, thermostatic controls, etc., to allow for the digestion of sludge, in one case at a temperature of 25–30° C. (low-temperature digestion), and in the other at a temperature of 50–55° C. (thermophilic digestion), was described in the appendix to last year's report.

A preliminary account was also given in that report of the results obtained during the first six months' operation.

During the period under review further experiments have been carried out with reference to the digestion of mixed sludge, *i.e.*, mixtures of sedimentation (or septic) tank sludge and activated sludge in the proportions of 6 : 1 calculated to the basis of their dry organic matter (D.O.M.) contents. A series of experiments have been carried out also with reference to the digestion of activated sludge alone.

Digestion of "mixed" sludge.

Following on the experiments using "mixed" sludge carried out on the "batch" system, which were described in last year's report, experiments, in which each day (except Sundays) small quantities of fresh sludge were added, were commenced on July 21st, 1931. These experiments were continued over a period of 155 days.

In general, the method of operation adopted was as follows:—

> After the discharge from the digestion tanks of the required volume of water and/or digested sludge an equal volume of fresh sludge, previously heated to the required temperature, was mixed with a small quantity of digested sludge withdrawn from the base

of the digestion chambers. The mixture of fresh and digested sludge was then pumped into the digestion unit, the ingoing sludge being sprayed about the surface of the contents of the tank by use of a "splash plate." The upper layer of the contents of the tank was then stirred by hand and circulated by means of the pump in order to obtain a thorough mixture of the fresh sludge with the digested sludge, top water, and scum.

Careful measurements were always made of the volumes of the water and digested sludge withdrawn and of the fresh sludge added. The water and sludges were sampled and analysed. A record was also kept of the volume of gas evolved and the composition of the gas was determined from time to time.

Further, with the view of obtaining reliable data of the character of the contents of the digestion chambers, and for stocktaking purposes, occasionally the whole contents of the digestion units were thoroughly mixed by stirring the scum and by complete circulation with the aid of the pump for a period of not less than one hour. Samples of the final mixture were then taken for analysis.

Digestion of sludge at 25–30° C.

The "seeder" at the commencement of this section of the inquiry consisted of well-digested sludge in an active fermenting condition, such as was obtained during the previous "batch" working period.

At the outset, comparatively small volumes of mixed sludge were added daily, with the exception of Sundays. As the trial proceeded, and as the results warranted, the amount of sludge dealt with daily was gradually increased, and eventually a seven-day week was adopted.

The volume of sludge dealt with daily varied from a minimum of 146 gallons, containing 110lbs. of dry solids, of which 62·5lbs. was organic matter, to a maximum of 277 gallons, containing 190lbs. of dry solids, of which 109lbs. was organic matter.

The gas evolved varied from 248 to 392 cubic feet per day, which, in terms of the dry organic matter, is equivalent to a variation of from 2·86 to 4·58 c. ft. per lb., or 179 to 286 cubic centimetres per gramme.

The detention period in terms of input sludge varied from 11 to 20 days. Based on a sludge containing 94% of water this is equal to a variation of 10 to 17 days, and on a sludge containing 90% water the variation is from 19 to 29 days. These calculations make no allowance for redigestion of the suspended matter (imperfectly digested sludge) escaping in the "water" withdrawn from the digestion tank.

The best results were obtained during a 22 days' run in November and December last, when a total of 55,500lbs. of wet sludge, with an average water content of 93·2%, were dealt with. This is equal to a detention period of 23·6 days for a sludge containing 90% water or 13·6 days for a sludge of 94% water content, after making an allowance for the redigestion of the partially-digested sludge escaping in the "water" withdrawn from the digestion unit.

During this period the total gas yield was 8,157 c. ft., an average of 371 c. ft. per day, equivalent to 3·8 c. ft. per lb., or 238 cubic centimetres per gramme of dry organic matter in the sludge treated.

It was not found possible to improve on these results. Subsequent attempts to increase the daily volume of sludge dealt with resulted in a loss of fermentation activity, as shown by (*a*) a fall in the gas yield; (*b*) a definite lowering of the *p*H value of the contents of the digestion chamber; and (*c*) difficulty in obtaining a good separation of supernatant water.

There is, however, every reason to believe that the above-mentioned results could be maintained when working with the mixed (sedimentation and activated) sludge produced under normal conditions.

Comparison of these results with those obtained previously, when operating under the "batch" system, shows that the "daily addition" method of operation is to be preferred by reason of (*a*) greater ease of manipulation; (*b*) more rapid digestion, *i.e.*, reduced digestion-tank capacity; and (*c*) more regular evolution of gas.

There is, however, one question which requires further consideration and that is in connection with the separation of supernatant water relatively free from undigested sludge. At the moment this partially-digested sludge would have to be returned with the withdrawn water to the sewage inlet for retreatment, or means will have to be adopted for its separation and return direct to the digestion unit.

In this connection it may be stated that, having in mind this difficulty, certain preliminary laboratory experiments have already been undertaken in which a two-stage digestion process has been developed, from which it would appear the following advantages may accrue:—

(*a*) A more ready separation of a greater volume of "good quality" water;

(*b*) A more thoroughly digested sludge of greater density (less bulk); and

(*c*) A reduction of the detention period required in heated tanks.

These preliminary trials must be confirmed and extended on a larger scale before any definite conclusions can be drawn as to the economic value of a two-stage process.

"Thermophilic" digestion of "mixed" sludge at 50–55° C.

The general procedure adopted in establishing the "daily addition" system of operation was similar to that previously described, but the volume of sludge treated daily in the initial stages was increased more gradually, owing to the fact that the "seeder" had apparently not reached its maximum activity.

At the end of nine weeks active conditions had been well established, and results were obtained little, if any, inferior to those yielded at the lower temperature (25–30° C.) in so far as detention period and gas evolution are concerned.

Subsequently there was a further improvement, and eventually satisfactory digestion was maintained with a very slightly less detention period than that required when working at the lower temperature, and, moreover, the difficulty in obtaining a good separation of partially-digested sludge from the "water" withdrawn from the digestion unit was not nearly so pronounced.

Over a period of 41 days 107,747lbs. of wet sludge, containing 93·7% water, were dealt with, which is equivalent to a detention period of 23·0 days for a sludge of 90% water content and 13·3 days for a sludge containing 94% water, after making allowance for redigestion of the sludge withdrawn in the "water."

The total gas yielded during this period was 14,049 c. ft., an average of 343 c. ft. per day, equal to 3·56 c. ft. per lb. or 223 cubic centimetres per gramme of dry organic matter in the sludge dealt with.

Summary of results ("mixed" sludge digestion).

In so far as single-stage digestion of a mixture of equal volumes of sedimentation tank sludge and of activated sludge is concerned, this inquiry may be said to have determined, within limits, the conditions and requirements necessary for the satisfactory treatment of the sludge to be produced in the future at Davyhulme.

Although the results of thermophilic digestion (50–55° C.) of sludge during the period now reported upon show a considerable improvement on those previously reported, this prolonged and detailed inquiry has furnished no evidence of any outstanding advantage such as would warrant its adoption in preference to digestion at the lower temperature of 25–30° C.

Apparently any advantage it may have is concerned mainly with the nature of the separated water, which allows a better removal therefrom of the suspended solids, and it is more than probable that the difficulty experienced in this direction when operating at 25–30° C. would be overcome by the adoption of a suitably arranged two-stage digestion process.

The accumulated results appear to warrant the conclusion that, operating at 20–25° C., a digestion tank capacity equal to 14 days' production of input sludge, containing approximately 94% water, would be adequate to deal satisfactorily with the mixed sludge which will have to be dealt with in the future at Davyhulme, with the production of a sludge sufficiently digested to allow of its subsequent treatment on drainage beds or disposal on land, without giving rise to aerial nuisance.

Digestion of Activated Sludge.

On the conclusion of the inquiry into the digestion of a mixture of equal volumes of sedimentation tank sludge and activated sludge, an active "seeder" was brought by suitable stages to treat the latter sludge alone.

The activated sludge employed was taken from the demonstration unit at the Davyhulme Works. By means of preliminary decantation it was possible to obtain a sludge with a water content varying from 97·5 to 98·25%, and this is about as dense a sludge as is likely to be obtained in practice by simple sedimentation without resort to special mechanical treatment.

The results of several months' experience in the digestion of activated sludge are summarised in the following statements.

Digestion of activated sludge at 25–30° C.

Having built up an active "seeding" sludge, an average daily volume of 280 gallons of sludge, containing 98·0% water, was dealt with during the first month. Gas was evolved at the average rate of 180 c. ft. per day, equivalent to 4·86 c. ft. per lb., or 303 c.c. per gramme of the dry organic matter (D.O.M.) in the fresh sludge added.

An unsatisfactory feature of the digestion process during this initial period was the frequent relatively heavy load of suspended solids (partially digested sludge) in the water withdrawn, whilst the water content of the digested sludge rose from 94·5% on the 9th day to 96·4% on the 28th day. Further, it was noted that the *p*H value of the water withdrawn showed a tendency to decrease.

Subsequent attempts to increase the daily volume of fresh sludge dealt with were accompanied by a marked reduction in gas production, which fell to 99 c. ft. per day, and this was coincident with a very low *p*H value of the digested sludge.

At this stage several weeks were required to re-establish a satisfactory digestion. In the main this was accomplished by increasing the digestion period by adding smaller batches of fresh sludge on alternate days only. During the course of this recuperative period the *p*H value of the whole of the contents of the digestion chamber rose to 7·9.

Inasmuch as the interference with the digestion process in the earlier trials was doubtless due to the loss of active sludge (seeding material) in the water withdrawn prior to recharging with fresh sludge, steps were taken to remedy this defect in the later trials. In the later stages of the period covered by this report, therefore, the “ water ” withdrawn from the digestion chamber was allowed to settle for 18–20 hours in a tank provided for the purpose, and the deposited sludge was returned with the incoming fresh sludge to the digestion chamber.

Working in this way the digestion process was satisfactorily maintained and improved results were obtained.

A trial run of 23 days yielded the following results, which may be taken as typical of this period :—

Fresh sludge added per day	234 gallons
Water content	97·43%
Organic matter in dry solids	69·0%
D.O.M. added per day	42·4 lbs.
Gas yield per day	161 c. ft.
Gas yield per lb. D.O.M. added	3·83 c. ft.
Gas yield per gramme D.O.M. added	238 c.c.
Water decanted per day	103 gallons
Solids content	0·31%
Digestion sludge withdrawn	127 gallons
Water content	97·6%
Organic matter in dry solids	59·3%

The average detention period in the digestion chamber during this period was 13·8 days in terms of the volume of fresh input sludge, or 10·7 days calculated on the basis of a sludge containing 98·0% water.

“ *Thermophilic* ” *digestion of activated sludge at 50°–55° C.*

The thermophilic digestion trials were carried out alongside those at the lower temperature just described, and for the first month similar amounts of sludge were treated daily.

The digestion process proceeded satisfactorily, and although in the early stages the density of digested sludge was reduced and the *p*H value of the withdrawn water and sludge was lowered from 8·5 to 7·5, it did not, as in the case of the lower temperature trials, cause any serious interference with the maintenance of a satisfactory digestion.

Later on the water withdrawn daily from the digestion chamber, which was very large in volume, was allowed to settle for 18–20 hours and the deposited partially-digested sludge returned to the digestion chamber with the incoming fresh activated sludge.

The daily volume of fresh sludge dealt with was gradually increased from 280 gallons until eventually rather more than 500 gallons of new sludge was added daily to the digestion chamber (total capacity 3,200 gallons), and by this time the plant was handling daily sludge containing as much as 97lbs. of dry organic matter.

The results obtained during three separate periods towards the end of this trial are summarised below :—

	Period		
	(*a*) 49 days	(*b*) 42 days	(*c*) 14 days
Fresh sludge added per day : gallons	401	453	514
Water content	98·02%	97·66%	97·36%
Organic matter in dry solids	70·86%	69·99%	69·67%
Lbs. D.O.M. added per day	57·4	75·7	97·1
Gas evolved : c. ft. per day	273	324	390
Equal to c. ft. per lb. D.O.M. ..	4·75	4·28	4·01
Equal to c.c. per gramme	297	268	251
Water decanted per day : gallons ..	290	267	243
Dry solids content	0·42%	0·42%	0·88
Digested sludge withdrawn per day : gallons	103	168	229
Water content	97·07%	97·01%	97·71%
Organic matter in dry solids	60·07%	59·52%	61·84%
Average detention period— Based on input sludge	8·0 days	7·2 days	6·3 days
Calculated on 98·0% sludge ..	8·1 days	6·2 days	4·8 days

Reduction in volume of activated sludge.

It has not been found possible to obtain sludge digested at either temperature with a water content below 97% as withdrawn from the digestion chamber, and generally the water content has varied from 97·0 to 97·7%.

Since the cost of the subsequent handling of the sludge is more or less controlled by its volume rather than by its dry solids content, laboratory experiments were undertaken to determine the extent to which the density of the sludge could be increased by subsequent settlement and/or fermentation at atmospheric temperature.

In the following paragraphs are given the actual results from the digestion chambers and the further reduction in volume that may be anticipated from a consideration of the above-mentioned laboratory experiments :—

1. Digestion of activated sludge at 25° to 30° C., 65-day working period—

14,424 gallons of pre-settled fresh input sludge containing 97·79% water yielded 6,335 gallons of digested sludge containing 97·42% water, a reduction in bulk of 56%.

Laboratory experiments have demonstrated that this sludge may be reduced to one-half its volume by secondary digestion at atmospheric temperature for 10 to 20 days. This means a total reduction of 78%, or that the sludge, after final digestion, only occupies 22% of the pre-settled fresh sludge handled.

2. "Thermophilic" digestion of activated sludge at 50° to 55° C., 91-day working period—

38,670 gallons of pre-settled input sludge containing 97·84% water yielded 12,125 gallons of digested sludge with a water content of 97·04%, a reduction in bulk of 69%.

Since laboratory experiments demonstrated that the volume of this sludge may be reduced to the extent of 30% by settlement (at atmospheric temperature) for two days, then the volume of the final sludge to be handled would be 22% of the original pre-settled fresh sludge. If this subsequent settlement period is increased to ten days, then the volume of the digested sludge may be reduced by one-half, and the finished product would only occupy 16% of the volume of the original undigested sludge.

Digestion of Activated Sludge :—

Summary of results to date.

Contrary to the previous experience in the digestion of "mixed" sludge, decidedly better results have been obtained by the thermophilic digestion of activated sludge than when operating at the lower temperature of 25° to 30° C.

An explanation of this difference is apparently associated with (*a*) a more rapid "clotting" effect on the fresh activated sludge at the higher temperature with a better separation of water, and therefore less liability to loss of "seeder" in the water withdrawn ; (*b*) to a more pronounced ammoniacal fermentation with the maintenance of a higher *p*H value ; and (*c*) difference in composition of the sludge dealt with, *e.g.*, activated sludge, although containing a higher percentage of organic matter (dry solids), contains very much less greasy matter than does the "mixed" sludge in laboratory experiments previously described.

At this stage it may be well to summarise briefly the position, so far as this inquiry has gone, in respect of the short-period digestion of activated sludge.

Quite apart from economic considerations, and with the knowledge that the process requires development in certain directions, it would appear safe to assume the following minimum probabilities :—

1. That activated sludge containing 98% water can be digested at a temperature of 25° to 30° C. in 10 or 11 days, calculated on a volumetric basis, with a reduction in the bulk of the original sludge of three-fifths, whilst by a second-stage digestion at atmospheric temperature for from 10 to 20 days the volume of digested sludge to be handled would only be one-fifth of the original fresh activated sludge.

2. That activated sludge containing 98% water can be digested at a temperature of 50° to 55° C. in five or six days, calculated on a volumetric basis, with a reduction of seven-tenths of its volume, whilst subsequent settlement of the digested sludge (at atmospheric temperature) for some days would yield a sludge occupying only one-sixth to one-seventh the volume of the original fresh activated sludge.

In conclusion it should be stated (*a*) that, presumably owing mainly to its high water content, digested activated sludge is not so readily dewatered on drainage beds as is the product resulting from the digestion of a mixture of equal volumes of sedimentation sludge and activated sludge ; (*b*) that the problem of the satisfactory digestion of activated sludge, at either temperature, centres round difficulties (economic and operational) associated with the high water content not only of the fresh sludge, but also of the digested sludge as withdrawn from the digestion chamber ; and (*c*) it has not been demonstrated that the total thermal value of the fermentation gases is sufficient to maintain a temperature of 25° to 30° C. throughout the year, much less the higher temperature. This is of course due to the huge volumes of water which have to be heated to the required temperature in relation to the actual solid matter present. It would thus appear essential from the economic point of view to arrange for preliminary densification of the activated sludge by mechanical means prior to digestion and/or to increase its density by the addition of a certain proportion of sludge from the sedimentation tanks. It is along these lines that this research is being continued, and special attention will be paid to the possibilities of a second-stage digestion of the resultant sludge at atmospheric temperature.

MANCHESTER CORPORATION — RIVERS DEPARTMENT

DAVYHULME SEWAGE WORKS

:: DIAGRAM OF SEWAGE TREATMENT OPERATIONS ::

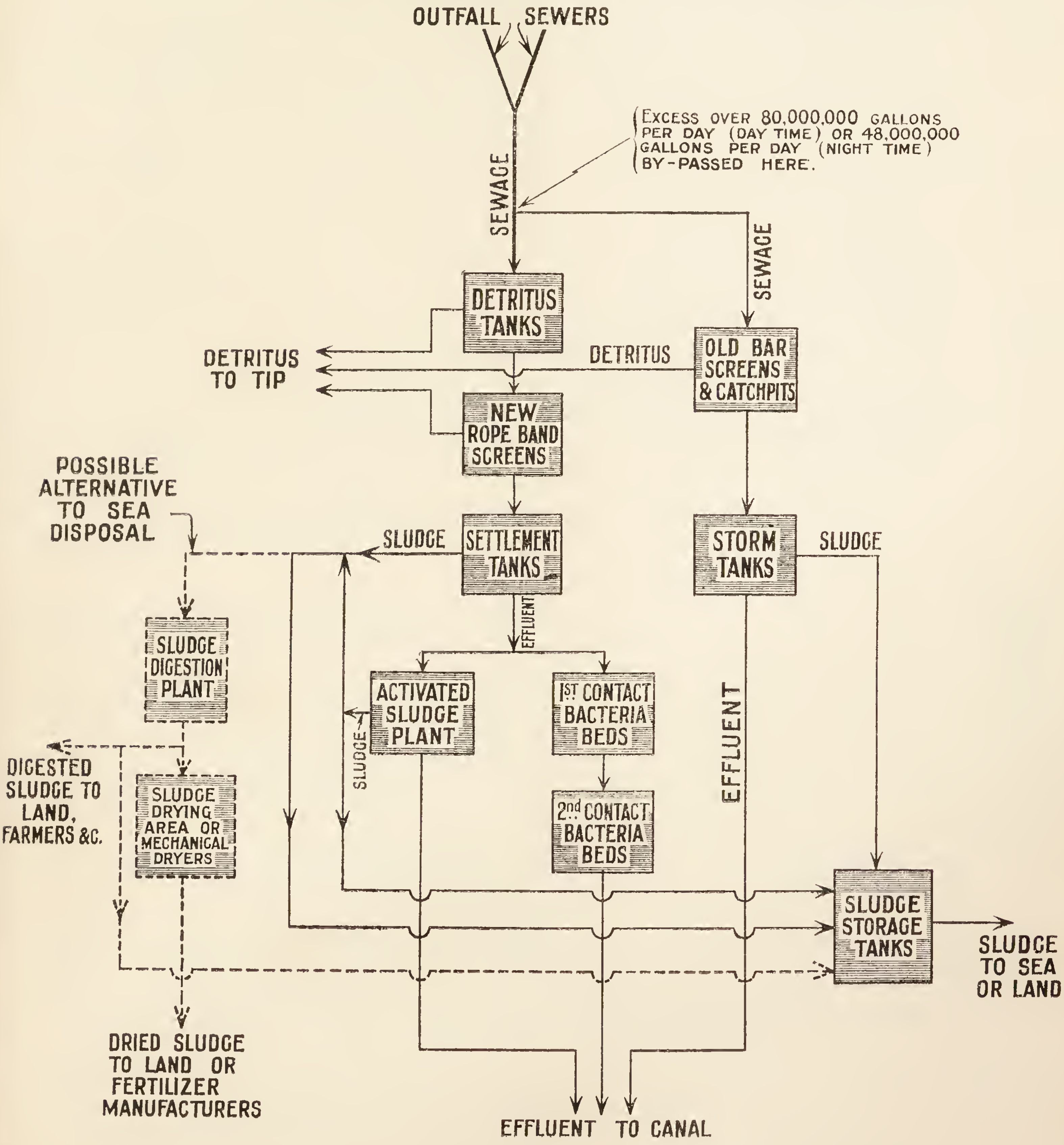

OUTFALL SEWERS
EXCESS OVER 80,000,000 GALLONS PER DAY (DAY TIME) OR 48,000,000 GALLONS PER DAY (NIGHT TIME) BY-PASSED HERE.
SEWAGE
SEWAGE
DETRITUS TANKS
DETRITUS TO TIP
DETRITUS
OLD BAR SCREENS & CATCHPITS
NEW ROPE BAND SCREENS
POSSIBLE ALTERNATIVE TO SEA DISPOSAL
SLUDGE
SETTLEMENT TANKS
STORM TANKS
SLUDGE
EFFLUENT
SLUDGE DIGESTION PLANT
ACTIVATED SLUDGE PLANT
1ST CONTACT BACTERIA BEDS
EFFLUENT
SLUDGE
DIGESTED SLUDGE TO LAND, FARMERS &C.
SLUDGE DRYING AREA OR MECHANICAL DRYERS
2nd CONTACT BACTERIA BEDS
SLUDGE STORAGE TANKS
SLUDGE TO SEA OR LAND
DRIED SLUDGE TO LAND OR FERTILIZER MANUFACTURERS
EFFLUENT TO CANAL

Table I.

GENERAL RIVERS WORK.

Costs—1931–32.

	£	s.	d.	£	s.	d.
Surveillance of Manufacturers' Trade Effluents				278	7	2
Surveillance of Rivers and Streams				371	7	2
Westhead's Weir—						
Routine Operation	56	11	8			
Maintenance	5	13	5			
				62	5	1
Birley's Weir—						
Routine Operation				....		
Maintenance				....		
Work in Rivers and Streams—						
River Medlock	104	14	4			
Other Rivers and Streams	27	11	9			
				132	6	1
Contribution to Rivers Mersey and Irwell Joint Committee ..				1,950	0	0
Contribution to Rivers Mersey and Irwell Catchment Board ..				2,717	12	10
Culverting of Rivers and Streams by Owners. Engineering Department's Supervision				21	17	11
Settling Basin on River Medlock at Clayton				5	0	0
Committee and Central Office Administration and Consulting Services (Proportion)				52	5	7
				5,591	1	10
Less :						
Rents and Privileges	*9*	*9*	*3*			
Sale of Sundry Materials, etc.	*2*	*9*	*1*			
				11	*18*	*4*
				£5,579	3	6

WITHINGTON SEWAGE WORKS.

Table II.

Cost of Sewage Treatment, 1931-32.

	£	s.	d.	£	s.	d.	
SCREENS AND CATCHPITS—							£757 4s. 3d.
Routine Cleaning and Operation	115	19	1				
High-level Screen Maintenance	0	8	3				
Low-level Screen Maintenance	4	8	8				
Conical Catchpit Detritus Removal	37	6	5				
Conical Catchpit Maintenance	....						
				158	2	5	
SETTLEMENT TANKS—							
Routine Cleaning and Operation	135	16	8				
Emscher Tank Maintenance	0	14	10				
Sedimentation Tank Maintenance	....						
Detritus Tank Maintenance	3	13	2				
				140	4	8	
SLUDGE DISPOSAL ON LAND—							
Digging, Filling, and Covering Grips and Lagoons	273	0	3				
Ejector and Pipe Maintenance	0	14	1				
Emscher Sludge Beds and Drying Ground	43	14	1				
Ejector House Maintenance	....						
Electric Current and Supervision	25	5	11				
Power House Charges (proportion)	100	11	5				
Air-Compressor Maintenance	3	4	1				
Installation of Sludge Pipe from Emscher Tank to No. 2 Sedimentation Tank	14	1	4				
	460	11	2				
Less: Sale of Sludge	*1*	*14*	*0*				
				458	17	2	
BACTERIA BEDS—							
Routine Operation	315	0	11				
Primary Beds; Medium Surface Maintenance	232	18	11				
Secondary Beds: Medium Surface Maintenance	347	3	9				
Storm Beds; Medium Surface Maintenance	169	17	4				
				1,065	0	11	
CARRIERS—							
Routine Cleaning	9	19	8				
Maintenance	1	13	2				
				11	12	10	
ACTIVATED SLUDGE PLANTS—							
No. 1 Plant:							
Routine Operation	87	11	5				
Tank Fabric Maintenance	....						
Tank Equipment Maintenance	58	1	0				
No. 2 Plant:							
Routine Operation	115	4	5				
Tank Fabric Maintenance	....						
Tank Equipment Maintenance	40	18	6				
Electric Current and Supervision	802	17	7				
Power House Charges (proportion)	201	2	10				
No. 1 (Jones & Attwood) Compressor Maintenance	23	1	4				
No. 2 (Jones & Attwood) Compressor Maintenance	10	1	6				
No. 3 (Tilghman) Compressor Maintenance	1	10	6				
Erection of Steam Diffuser Cleaning Plant	12	19	9				
				1,353	8	10	
STORM-WATER PUMP AND RESERVOIR—							
Pump Operation	1	5	7				
Pump Maintenance	0	18	1				
Pump House Maintenance	....						
Storm-water Reservoir Cleaning	4	17	6				
				7	1	2	
LABORATORY—							
Routine Work	395	18	9				
Building Maintenance	1	12	4				
Maintenance of Gas Chamber and Main. Emscher Tank to Laboratory	1	1	10				
				398	12	11	

	£	s.	d.	£	s.	d.	£	s.	d.
RIVER BANK AND CHORLTON BROOK BANK MAINTENANCE							128	12	7
ROAD MAINTENANCE							16	18	3
FENCING							7	9	1
GREASE RECOVERY							(a) 16	7	4
LAND CULTIVATION—									
Routine Work				271	13	4			
Implement Repairs				2	15	2			
				274	8	6			
Less: Produce grown on Farm Land—									
Sales	*163*	*6*	*9*						
Consumed in Stables	*39*	*12*	*2*						
				202	*18*	*11*			
							71	9	7
MONETARY ALLOWANCES—									
Sickness				20	4	2			
Workmen's Compensation				....					
Additional to Superannuation				33	14	3			
							53	18	5
COTTAGES—									
No. 1 Cottage Maintenance				7	12	8			
No. 2 Cottage Maintenance				0	10	7			
Tenancy Services				0	12	5			
							8	15	8
PUMPING—									
Electric Current and Supervision				546	14	5			
Power House Charges (proportion)				402	5	6			
No. 1 (19in.) Pump Maintenance				0	12	5			
No. 2 (10in.) Pump Maintenance				....					
No. 3 (10in.) Pump Maintenance				....					
No. 4 (15in.) Pump Maintenance				....					
No. 5 (2in.) Pump Maintenance				....					
							949	12	4
WORK FOR OUTSIDE PARTIES (RECOVERABLE)							10	19	4
WEED REMOVAL AND DISPOSAL							33	12	10
GARDENING							18	18	5
CLEANING DITCHES AND WATERCOURSES							9	15	9
MEADOWS							14	6	5
EDUCATIONAL FACILITIES							9	1	2
RENTS, RATES, AND TAXES							999	11	8
WORKS ADMINISTRATION—									
Routine Work				405	19	5			
Administrative Building Maintenance				....					
Foreman's Residence Maintenance				20	5	2			
							426	4	7
COMMITTEE AND CENTRAL OFFICE ADMINISTRATION AND CONSULTING SERVICES (PROPORTION)							426	6	8
							7,095	1	0
Less:									
Sale of Grease				(a) *56*	*4*	*11*			
Sale of Sundry Materials				*4*	*8*	*3*			
Rents of Cottages and Land				*118*	*17*	*7*			
Work for Outside Parties				*11*	*4*	*1*			
							190	*11*	*10*
							£6,904	6	2

	£	s.	d.
Average cost per million gallons	5	6	6·8
Average cost per million gallons for year ended 25th March, 1931	5	3	6·3
Average cost per head of population connected to sewers	0	2	1·5
Average cost per head of population connected to sewers for year ended 25th March, 1931	0	2	1·8

COST OF SEWAGE TREATMENT, 1931-32.

NORTHENDEN SEWAGE WORKS.

	£	s.	d.	£	s.	d.
SCREENS AND DETRITUS TANKS				11	12	4
SEDIMENTATION TANKS				50	1	0
STORM TANKS				2	12	9
NIGHT TANK				3	16	10
PUMPING SEWAGE TO SEDIMENTATION TANKS				88	0	5
SPRINKLING FILTERS				0	11	5
HUMUS TANK—						
Cleaning and Routine Operation	16	1	5			
Maintenance	17	7	3			
				33	8	8
LAND TREATMENT OF SEWAGE				36	14	4
CARRIERS				10	15	5
SLUDGE DISPOSAL—						
Pumping and Routine Work	85	12	6			
Construction of additional Sludge Beds	107	17	3			
Bed Maintenance	15	12	5			
No. 4 Sludge Pump Maintenance	0	19	6			
				210	1	8
GARDENING				35	3	6
ATTENDANT'S HOUSE MAINTENANCE				21	12	4
ROADS AND FENCES				3	1	8
WEED REMOVAL AND DISPOSAL				56	18	0
RENTS, RATES, AND TAXES				54	17	0
WORKS ADMINISTRATION				56	15	11
COMMITTEE AND CENTRAL OFFICE ADMINISTRATION AND CONSULTING SERVICES (PROPORTION)				41	6	4
				717	9	7
Less: Rent of Land				*2*	*0*	*0*
				£715	9	7

	£	s.	d.
Average cost per million gallons	6	12	10·6
Average cost per head of population connected to sewers		2	11

	£	s.	d.
HEYHEAD SEWAGE INSTALLATION	6	7	1
COMMITTEE AND CENTRAL OFFICE ADMINISTRATION AND CONSULTING SERVICES (PROPORTION)	0	7	11
	£6	15	0

MOSS SIDE SEWAGE WORKS.

	£	s.	d.	£	s.	d.
BUILDING MAINTENANCE—						
Caretaker's Residence	0	19	5			
Tenant's Residence	3	2	4			
Outbuildings	7	0	1			
				11	1	10
SLUDGE LAGOONS				71	15	7
GENERAL CLEANING, FENCING, AND SUNDRIES				26	17	1
CARETAKER'S EMOLUMENTS				6	14	11
RENTS, RATES, AND TAXES				26	1	3
WATER SUPPLY AND MAIN MAINTENANCE				20	13	0
CARRIERS AND OUSEL BROOK CLEANING				8	8	2
SUPERVISION				16	15	0
COMMITTEE AND CENTRAL OFFICE ADMINISTRATION AND CONSULTING SERVICES (PROPORTION)				11	14	3
				200	1	4
Less:						
Rent of House, Privileges, and Sundries				*70*	*12*	*5*
				£129	8	11

MIDDLETON SEWAGE WORKS.

	£	s.	d.	£	s.	d.
RENTS, RATES, AND TAXES				44	17	9
SETTLEMENT TANKS—						
Routine Work	31	11	1			
Maintenance	....					
				31	11	1
SLUDGE LAGOONS—						
Routine Work	107	17	8			
Maintenance	41	14	1			
				149	11	9
GENERAL CLEANING AND SUNDRIES				13	3	7
SUPERVISION				17	16	6
COMMITTEE AND CENTRAL OFFICE ADMINISTRATION AND CONSULTING SERVICES (PROPORTION)				15	19	8
				273	0	4
Less:						
Rent of Building				*20*	*0*	*0*
				£253	0	4

GORTON SEWAGE WORKS.

	£	s.	d.
CLEANING, FENCING, AND WEED DISPOSAL	15	7	1
RENTS, RATES, AND TAXES	302	14	9
SUPERVISION	16	15	8
COMMITTEE AND CENTRAL OFFICE ADMINISTRATION AND CONSULTING SERVICES (PROPORTION)	2	0	0
	£336	17	6
Less:			
Privilege	*1*	*0*	*0*
	£335	17	6

DAVYHULME SEWAGE WORKS.

Cost of Sewage Treatment, 1931–1932.

		£ s. d.	£ s. d.
Detritus Tanks:—			
Cleaning and Routine Operation		1,485 5 0	
Fabric Maintenance		26 12 10	
Pump Maintenance		0 17 2	
Pump House Maintenance		3 8 9	1,516 3 9
Screening:—			
No. 1 Plant			
Cleaning and Routine Work		548 2 8	
No. 1 Screen Maintenance		1 11 8	
No. 2 Screen Maintenance		21 7 0	
Chamber Maintenance		27 13 7	598 17 11
No. 2 Plant			
Cleaning and Routine Work		1,836 3 11	
No. 2 Screen Maintenance		43 18 10	
No. 3 Screen Maintenance		20 6 4	
No. 4 Screen Maintenance		66 0 10	
No. 5 Screen Maintenance		12 0 8	
Chamber Maintenance		10 10 3	
		1,989 0 10	
Less: Sale of Screenings		29 5 0	1,959 15 10
Settlement Tanks:—			
Cleaning and Routine Operation		579 5 4	
Fabric Maintenance		50 4 0	
Pump Maintenance		25 3 8	654 13 0
Sludge Ejectors:—			
Routine Operation		681 5 5	
No. 1 Ejector Maintenance		11 12 7	
No. 2 Ejector Maintenance		13 16 0	
Air Main Maintenance		12 7 5	
Nos. 3 and 4 Ejectors Maintenance		3 5 1	
1" Pump and Motor Maintenance		0 17 8	
Sludge Main Maintenance		4 3 9	
Ejector Chamber Maintenance		5 17 11	733 5 10
Sludge Storage Tanks:—			
Routine Cleaning and Operation		98 5 6	
Tank Fabric Maintenance		0 2 3	98 7 9
Sludge Beds:—			
Routine Operation		69 3 7	
Medium Renewal		128 5 1	197 8 8
Sludge Disposal on Land:—			
Sludge Ploughing and Gripping		878 7 0	
Engine and Pump Operation		144 16 1	
Engine and Pump Maintenance		94 4 1	
Sludge Main and Distribution Pipe Maintenance		19 4 4	
Land Draining		745 5 9	
	£ s. d.	1.881 17 3	
Less: Produce grown on sludge land:—			
Sales	33 9 0		
Consumed in stables	25 10 0	58 19 0	1,822 18 3
Sludge Steamer:—			
Routine Running		7,586 15 3	
Canal Tolls, Insurances and Licenses		1,491 9 10	
Owners' Repairs and Renewals		1,393 4 4	
Jetty Maintenance		31 16 4	
Loading Pipe Maintenance		46 17 10	10,550 3 7
Sludge Pressing:—			
Plant Maintenance		9 14 11	
Building Maintenance		0 13 3	10 8 2
Dried Sewage Manure:—			
Drier and Plant Maintenance		10 19 9	
Building Maintenance		2 19 11	13 19 8
Gauging Sewage Flow:—			
Routine Work			22 18 11
Primary Beds:—			
Routine Operation		2,064 4 4	
Medium Surface Maintenance		2,195 4 4	
Fabric Maintenance		126 19 8	
Medium Renewal		*11,915 4 9	16,301 13 1
Secondary Beds:—			
Routine Operation		1,368 15 10	
Medium Surface Maintenance		1,876 18 9	
Fabric Maintenance		62 0 7	
Medium Renewal		†83 1 7	3,390 16 9
Carriers:—			
Routine Cleaning		9 10 6	
Fabric Maintenance		39 11 2	49 1 8
Activated Sludge Plant:—			
Routine Operation		872 15 1	
Tank Fabric Maintenance		....	
Tank Equipment Maintenance		37 1 2	
Air Compressing Plant Maintenance		0 17 6	910 13 9
Grease Recovery:—			
Routine Work			(a) 259 1 9
Road Repairs:—			
Davyhulme Works		43 0 3	
Flixton Estate		44 17 3	
Carrington Estate		... ..	87 17 6

£18,156 2s. 5d.

		£ s. d.	£ s. d.
Fencing:—			
Davyhulme Works		143 14 10	
Flixton Estate		2 10 7	146 5 5
River Mersey Bank Repairs:—			
Flixton Estate		113 7 6	
Carrington Estate		424 2 6	537 10 0
Land Cultivation:—			
	£ s. d.		
Routine Work	389 4 9		
Flixton Farm Buildings Maintenance	1 1 11	390 6 8	
Less: Produce grown on farm land:—			
Sales	200 10 11		
Consumed in stables	68 6 2	268 17 1	121 9 7
Gardening			386 19 4
Laboratory:—			
Routine Work	2,218 12 10		
Building Maintenance	46 5 5	2,264 18 3	
Less: Work for other Departments		12 12 0	2,252 6 3
Sludge Digestion Experimental Plant:—			
Construction of Tank (completion)		132 16 10	
Construction of Drying Beds (completion)		15 15 7	
Routine Operation		529 7 7	678 0 0
Davyhulme Parish Sewage:—			
Screening and Pumping—Routine Operation		465 1 4	
Screen, Ejector and Chamber Maintenance		2 0 8	
Air Main Maintenance		5 13 7	
Contact Beds—Medium Surface Maintenance		23 16 5	
Recorder Maintenance		3 1 2	
Contact Beds—Fabric Maintenance		0 11 10	
Sewage Main Maintenance		......	500 5 0
Monetary Allowances:—			
Sickness		147 13 3	
Workmen's Compensation		28 8 10	
Additional to Superannuation		55 12 0	
Compassionate		4 6 6	
Professional Services for Injured Workmen		12 2 0	248 2 7
Works Extensions:—			
Technical and Advisory Services		150 0 0	
Sundry Work		221 1 11	371 1 11
Weed Removal and Disposal			226 17 3
Cleaning Ditches and Watercourses:—			
Davyhulme Works		5 6 2	
Flixton Estate		6 5 7	11 11 9
Work for Outside Parties (Recoverable)			204 14 4
Land Tenancy Services			7 4 11
Dismantling No. 1 Crusher			64 16 1
Conversion of No. 2 Washer to No. 2 Crusher (completion)			35 4 8
Filling in Disused Lime Mixing Tanks (completion)			33 4 7
Construction of No. 3 Washer and No. 3 Crusher (incomplete)			754 5 5
Re-Conditioning Marshall Portable Steam Engine			44 6 4
Re Conditioning No, 1 Administrative Building			16 5 0
Sundry Unclassified Items			48 13 8
Rents, Rates, and Taxes:—			
Davyhulme Works		4,548 0 2	
Flixton Estate and Buildings		171 3 5	
Carrington Estate and Buildings		14 8 3	4,733 11 10
Works Administration:—			
Routine Work		2,631 19 11	
Administrative Buildings Maintenance		2 10 4	
Manager's Residence Maintenance		7 17 9	2,642 8 0
Committee and Central Office Administration and Consulting Services (Proportion)			3,323 1 1
			56,566 13 10
Less:—			
Sale of Sewage Grease		(a) 607 14 4	
Sale of Scrap Metal and Sundry Materials		222 6 10	
Rents of Farm Lands and Privileges		256 3 4	
Work for Outside Parties		342 15 0	1,428 19 6
			£55,137 14 4

	£ s. d.
Average cost per million gallons	2 16 5·9
Average cost per million gallons for year ended 25th March, 1931	3 8 4·4
Average cost per head of population connected to sewers	0 1 5·1
Average cost per head of population connected to sewers for year ended 25th March, 1931	0 1 6·8

In comparing these costs with the charge on the rates (see page 6), a Contribution of £11,764 4s 0d. from the Local Authorities of Stretford, Middleton, Royton, Audenshaw, and Barton, sums of £4,210 11s. 11d. (expended out of Bacteria Beds Renewal Account), £448 14s. 6d. (interest on Bacteria Beds Renewal Fund), and £363 2s. 11d. (recovered from Sludge Steamer Underwriters), must be deducted; and £300 14s. 6d. (recoverable from Sludge Steamer Underwriters) must be added.

*

WASHING.

Quantity.	Tons.
Fouled Medium Washed	29,163
Fouled Medium Rewashed	3,075
	32,238

Cost.	£ s. d.
No. 1 Washer	4,375 1 10
Refuse from Washer	418 18 5
	£4,794 0 3

Cost per ton = 2s. 11·7d.

SUMMARY.

	£ s. d.
Emptying Beds	1,738 9 7
Filling Beds	1,292 16 3
Washing Medium	4,794 0 3
Hauling to and from Beds	2,117 3 9
Hauling to Crusher, Crushing, and returning to Washer	498 12 3
Purchase of New Medium	1,527 4 3
	£11,968 6 4

Table V.

SUMMARY OF COST STATISTICS, 1931–32.

DAVYHULME SEWAGE WORKS.

SLUDGE DISPOSAL AT SEA—			
Cost per trip	£63	3	5·9
Cost per ton of sludge	0	1	4·7
SLUDGE DISPOSAL (INCLUDING SCREEN REFUSE AND DETRITUS)—			
Average cost per ton	0	1	6·8
RAIL TRANSPORT—			
Cost per locomotive and wagons per operative hour (excluding driver)	0	5	1·4
HORSE TRANSPORT—			
Cost per horse per working hour (excluding driver)	0	1	1·4
Cost of keep per horse per week	0	12	10·0
MOTOR TRANSPORT (25-cwt. " Morris ")—			
Cost per operative hour (excluding driver)	0	2	0·7
Miles run		8,108	
Average mileage per week			152·6
Miles run per gallon of petrol			10·9
Net cost per mile run	£0	0	6·3
STEAM SHOVEL—Cost per operative hour (excluding operator)	0	6	11·4
CLINKER WASHER—Cost per operative hour (excluding operators)	0	3	2·3
CRUSHER—Cost per operative hour (excluding operator)	0	0	9·8
GRAB CRANE—Cost per operative hour (excluding operator)	0	3	5·8
ROTOTILLERS—Cost per operative hour (excluding operators)	0	1	11·0
WORKSHOP EXPENSES (on cost per job-hour)—			
Locomotive Fitting Shop	0	0	5·4
General Fitting Shop	0	0	5·4
Blacksmith's Shop	0	0	11·8
Joiner's Shop	0	0	1·0
Painter's Shop	0	0	3·0

DAVYHULME WORKS.

COST OF SEWAGE DISPOSAL, 1896 to 1932.

Year ending		Maintenance charge		Capital charge		Total outlay on purification works to date	Total capital and maintenance charges		Per cent. purification of raw sewage		Average number of population connected to sewers
		Total per annum	Cost per head of population	Total per annum*	Cost per head of population		Total per annum	Cost per head of population	As measured by the 4 hours oxygen absorption test	As measured by the albuminoid nitrogen test	
		£	Pence	£	Pence	£	£	Pence	Per cent.	Per cent.	
December,	1896	15,780	10·4	8,129	5·4	162,572	23,909	15·8	.. ...	......	363,040
,,	1897	19,089	9·9	9,797	5·1	195,942	28,886	15·0	......	......	462,020
,,	1898	20,000	9·3	10,517	4·9	210,334	30,517	14·2	......	......	515,120
March,	1900	18,728	8·1	10,634	4·6	212,672	29,362	12·7	......	......	553,910
,,	1901	21,439	9·2	10,793	4·6	215,866	32,232	13·8	39	38	558,812
,,	1902	19,212	8·2	12,395	5·3	247,893	31,607	13·5	40	40	564,200
,,	1903	15,512	6·6	17,473	7·4	349,457	32,985	14·0	38	41	567,570
,,	1904	14,684	6·1	21,316	8·7	426,323	36,000	15·0	45	52	574,130
,,	1905	14,273	6·0	23,506	9·8	470,121	37,779	15·8	68	71	575,270
,,	1906	18,648	7·8	24,069	10·0	481,374	42,717	17·8	70	74	575,900
,,	1907	21,795	9·1	24,029	10·0	480,566	45,824	19·1	64	69	576,620
,,	1908	27,147	11·3	24,730	10·3	494,614	51,877	21·6	61	68	577,230
,,	1909	30,457	12·4	25,982	10·6	519,643	56,439	23·0	64	70	588,600
,,	1910	27,674	11·0	27,239	10·8	544,785	54,913	21·8	67	72	603,910
,,	1911	22,660	8·9	28,444	11·2	568,884	51,104	20·1	69	70	611,100
,,	1912	24,530	9·8	29,569	11·8	591,376	54,099	21·6	74	76	602,000*
,,	1913	28,730	11·4	29,928	11·9	598,567	58,658	23·3	74	76	605,000
,,	1914	31,634	12·3	30,540	11·9	610,794	62,174	24·2	77	78	616,000
,,	1915 (53 weeks)	32,347	11·4	30,832	10·8	616,637	63,179	22·2	71	71	682,000
,,	1916	30,871	9·8	30,857	9·8	617,149	61,728	19·6	71	72	755,000
,,	1917	26,818	8·5	31,121	9·9	622,425	57,939	18·4	68	71	755,000
,,	1918	30,798	9·6	31,121	9·7	622,425	61,919	19·3	62	63	768,000
,,	1919	34,954	11·0	31,121	9·8	622,425	66,075	20·8	58	61	764,000
,,	1920 (53 weeks)	61,805	19·4	31,683	9·9	633,676	93,488	29·3	54	60	765,000
,,	1921	92,595	28·8	31,840	9·9	636,805	124,435	38·7	51	55	770,500
,,	1922	97,298	31·5	32,088	10·3	641,764	129,386	41·9	54	59	741,600*
,,	1923	73,759	23·7	32,278	10·4	645,568	106,037	34·1	62	63	747,100
,,	1924	68,382	21·9	32,278	10·4	645,568	100,660	32·3	63	65	748,300
,,	1925	52,771	16·9	32,278	10·3	645,568	85,049	27·2	53	57	750,500
,,	1926 (53 weeks)	57,269	18·2	32,278	10·3	645,568	89,547	28·5	54	56	754,000
,,	1927	57,442	18·2	33,322	10·6	666,443	90,764	28·8	49	51	757,000
,,	1928	58,984	18·6	35,582	11·2	711,645	94,566	29·8	45	45	760,200
,,	1929	59,679	18·8	37,324	11·7	746,481	97,003	30·5	46	48	763,500
,,	1930	62,294	19·2	38,564	11·9	771,288	100,858	31·1	48	48	778,500‡
,,	1931	61,089	18·8	40,052	12·3	801,039	101,091	31·1	48	47	781,000
,,	1932 (372 days)	55,138	17·1	35,909	11·2	867,571	91,047	28·3	45	46	772,000*

NOTE.—The capital charges given above include the cost of all land purchases at Davyhulme and Flixton.

Up to and including 1931 the annual charges have been computed by taking 5 per cent. of the total outlay to date: the figure for 1932 is the actual charge.

* The estimation of the population connected to the sewers was revised in the light of the latest census returns.

‡ Adjusted by reason of diversion of sewage from the Withington Works.

SHIP CANAL WATER ABOVE WORKS OUTFALL.

DIAGRAM I.

INCUBATOR TEST.

3 MINUTES OXYGEN ABSORPTION.

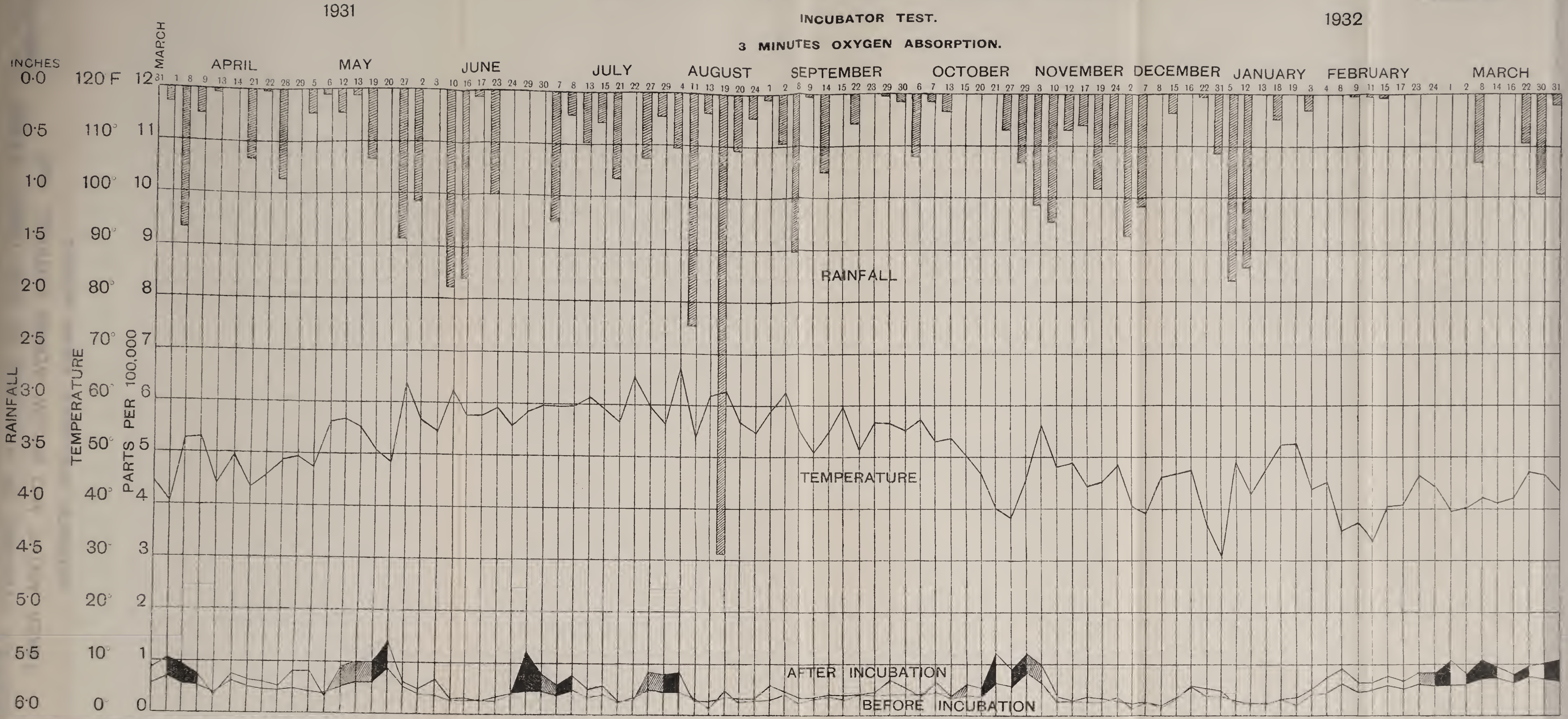
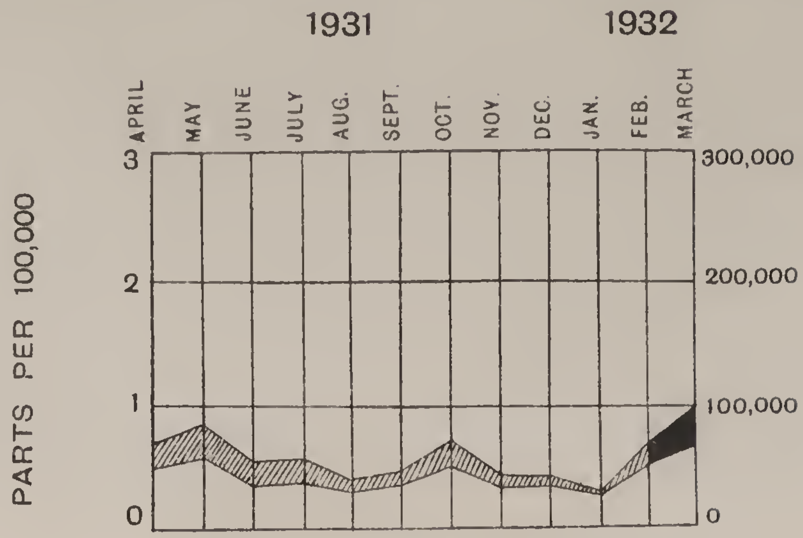


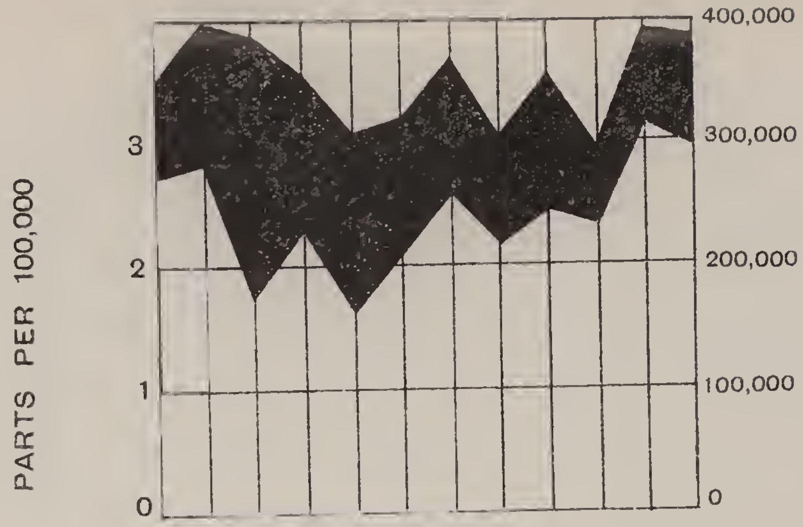
DIAGRAM 2.

MONTHLY AVERAGES OF ANALYSES OF SHIP CANAL WATER TAKEN ABOVE AND BELOW WORKS OUTFALL, AND AVERAGE EFFLUENT FROM WORKS.

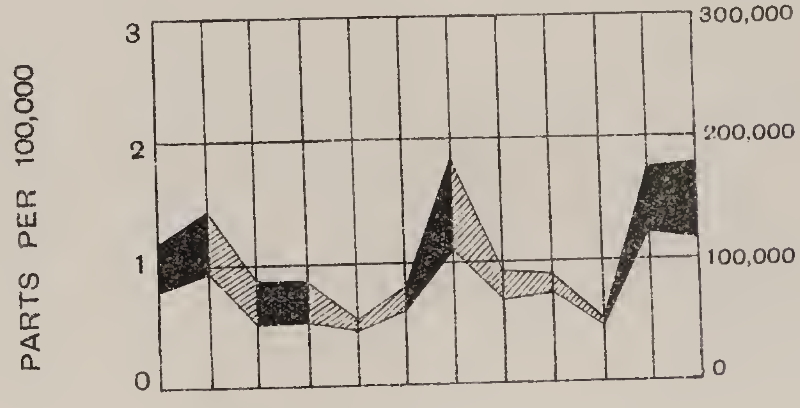
INCUBATOR TEST. **3 MINUTES OXYGEN ABSORPTION.**



ABOVE WORKS OUTFALL

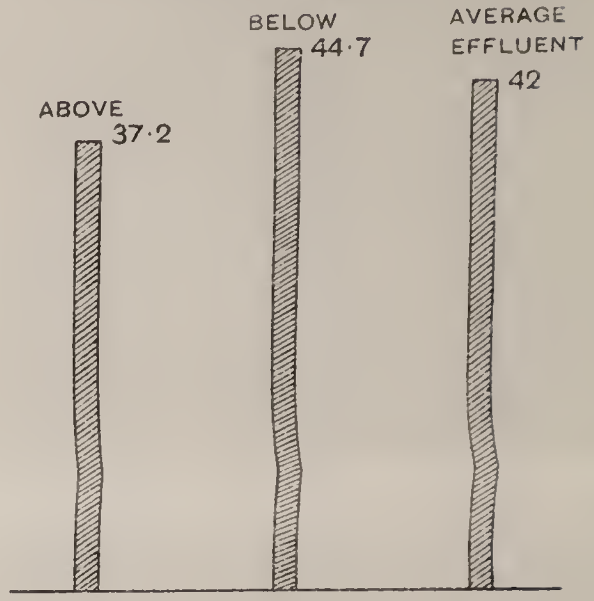


AVERAGE EFFLUENT



BELOW WORKS OUTFALL

AVERAGE PER CENT. INCREASE AFTER INCUBATION



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